Appendix A
Toxicity Profiles

POLYCHLORINATED BIPHENYLS (PCBs)

General Background Information

The thermal stability, nonflammability, and dielectric capability of PCBs resulted in their use in electrical capacitors and transformers (NIOSH, 1986). The manufacturing, processing, distribution in commerce, and use of PCBs after January 1, 1978 was prohibited under Section 6(e) of the Toxic Substances Control Act. PCBs can be released to the environment during fires involving electrical equipment containing these compounds. PCBs are strongly adsorbed on solid surfaces, including glass and metal surfaces in laboratory apparatus, and onto soils, sediments, and particulates in the environment.

Pharmacokinetics

Gastrointestinal absorption of most PCB isomers is large. PCBs can also be absorbed by the inhalation and dermal routes but limited data are available (see section on Relative Absorption Factors). Distribution of PCBs follows a biphasic pattern. Initially, PCBs distribute to liver and muscle tissue. They are then redistributed to the fat, skin, and other fat-containing organs (ATSDR, 1989). PCBs are poorly metabolized in humans with major metabolites being 3- or 4-hydroxy compounds. Metabolism may proceed through formation of arene oxide intermediates (U.S. EPA, 1988). The slow metabolism of PCB congeners to more polar compounds is responsible for long biological half-lives of PCBs. Excretion occurs primarily through the feces (Goto et al., 1974).

Human Toxicological Profile

Dermatologic signs are the most persistent indicator of PCB toxicity. Skin manifestations have been observed also in newborn infants of mothers exposed to high levels of PCBs and related compounds. Cases of severe chloracne were reported in a work environment in which PCB air levels were found to be between 5.2 and 6.8 mg/m^3. The workers developing chloracne had been exposed for 2 to 4 years. Other analyses revealed worker complaints of dry sore throat, skin rash, gastrointestinal disturbances, eye irritation, and headache at work area concentrations of 0.013 to 0.15 mg PCB/m^3. Higher blood PCB levels are associated with higher serum triglyceride and/or cholesterol levels, as well as high blood pressure. Air PCB concentrations as low as 0.1 mg/m^3 can produce toxic effects, and exposure to levels producing no overt toxicity can affect liver function. Recovery after termination of exposure occurs but is slow and depends upon the amount of PCBs stored in adipose tissue (Clayton and Clayton, 1981). Human exposures to PCBs resulting in toxic effects have almost all resulted from the ingestion of rice oil contaminated with "Kanechlor 400" in Japan (resulting in Yusho or rice oil disease) or from industrial exposure. Clinical symptoms of poisoning included acne-like skin eruptions (chloracne), eyelid edema, conjunctival discharge, skin and nail pigmentation, and hyperkeratosis. Yusho patients are estimated to have ingested approximately 0.07 mg/kg/day for at least 50 days. The rice oil was found to be contaminated with polychlorinated dibenzofuran, which is believed to have played a significant role in the observed toxicity (Bandiera et al., 1984; Kashimoto et al., 1981). As suggested by laboratory experiments with Rhesus monkeys, fetal and newborn primates, including humans, may be particularly susceptible to PCBs. Fein et al. (1984) studied the effects of low-level chronic exposure to PCBs in pregnant women and their newborn offspring from consumption of Lake Michigan fish. Low levels of PCBs were reported to cause decreases in birth weight, head circumference, and gestational age of the newborn. PCBs were apparently transmitted to the fetus across the placenta and to the newborn through breast milk. Behavioral deficiencies, including immaturity of reflexes and depressed responsiveness, were reportedly observed in infants exposed to PCBs. Jacobson et al. (1984) correlated maternal consumption of PCB-contaminated fish with behavioral abnormalities in newborns, including autonomic immaturity and depressed responsiveness. The authors likened these responses to similar effects in laboratory animals.

Mammalian Toxicological Profile

PCBs are only slightly toxic in acute exposures to laboratory animals. LD_{50} values for rats, rabbits, and mice are generally in the range of 1 to 10 g/kg body weight (U.S. EPA, 1980). Nonhuman primates seem to be particularly sensitive to PCB-induced reproductive effects (U.S. EPA, 1980). Dietary exposures of cynomolgus and Rhesus monkeys to 200 ug of Aroclor 1254/kg-day, 5 days per week for 28 months, resulted in symptoms of enlarged tarsal glands, conjunctivitis, loss of eyelashes, progressive detachment of fingernails, exuberant nail beds, hyperplasia of biliary ducts, hepatocellular enlargement and necrosis, and normocytic anemia (Tryphonos et al., 1986a; Tryphonos et al., 1986b). Effects were less pronounced in cynomolgus monkeys.

Monkeys that were fed diets containing 1.0 ppm of Aroclor 1016 for approximately 7 months prior to mating and during pregnancy delivered infants with reduced birth weights (Barsotti and Van Miller, 1984). Fetal mortality occurred at >2.5 ppm (0.1 mg/kg/day) of Aroclor 1248 in the diet in other studies with monkeys (Allen and Barsotti, 1976; Barsotti et al., 1976; Allen et al., 1980). In rats, a dose of 269 ppm of Aroclor 1254 given continuously in the food over the duration of pregnancy caused a decrease in the number of impregnated rats that delivered litters. Pups that were born were underweight, and most died within 7 days of birth. Two lower doses (26 and 2.5 ppm) caused altered neurobehavioral and somatic ontogeny (Overmann et al., 1987). PCBs have been shown to be teratogenic in mice. Cleft palate, dilated kidney pelvis, and thymus hypoplasia were observed. The ED50 (effective dose for 50% of the animals) for formation of cleft palate was a single 100 mg/kg dose, with peak sensitivity occurring on the twelfth day of gestation (d'Argy et al., 1987).

Immunological effects (decreased IgM, IgG induction) were noted in monkeys following a 27 month exposure at a dose of 0.005 mg/kg/day (Tryphonos et al., 1989).

Genotoxicity

Most genotoxicity assays of PCBs have been negative. The majority of microbial assays of PCB mixtures and various congeners show no evidence of mutagenic effects (U.S. EPA, 1980). The carcinogenic effects of PCBs have been studied in rats and mice. In a study conducted by Kimbrough et al. (1975) rats were exposed via the diet to 100 ppm Aroclor 1260 for 21 months. Hepatocellular carcinomas were observed in 26 of the 184 treated rats but only in one of the 173 controls. Neoplastic nodules were not found in controls but occurred in 144/184 of treated rats. The National Cancer Institute (NCI, 1978) reported a high incidence of hepatocellular proliferative lesions in male and female Fischer 344 rats fed three dose levels of Aroclor 1254 for 104-105 weeks, but, in part due to the small number of animals tested, carcinogenicity was not statistically demonstrable. Norback and Weltman (1985) fed a diet containing relatively high concentrations Aroclor 1260 (100 ppm for 16 months followed by 50 ppm for an additional 8 months) to Sprague-Dawley rats. In the PCB-exposed group, neoplastic nodules were observed at 12 months followed by trabecular carcinoma at 15 months and adenocarcinoma at 24 months (52/93). In the control rats, the incidence of hepatocellular neoplasms was low (1/81). Metastases to distant organs was not observed and mortality in the PCB exposed animals was not increased. The incidence of these slow-growing hepatocellular neoplasms was strikingly higher in female rats than in male rats.

PCBs (Clophen C) have also been shown to be cocarcinogenic. When PCBs were mixed with diethylnitrosamine (DENA), twice as many tumors were observed as were observed in animals treated with DENA alone (Brunn, 1987).

Based on the positive evidence for carcinogenicity of Aroclor 1254, Aroclor 1260, Kaneclor 500, and Clophen A-30 and A-60 in animals, along with adequate evidence in humans, the U.S. EPA has placed these PCBs in categroy B2 - probable human carcinogen (U.S. EPA, 1988).

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Source: MADEP Residential Short Form

ACENAPHTHENE

General Background Information

Acenaphthene is a member of the polycyclic aromatic hydrocarbons (PAH). PAHs are a class of non-polar compounds that contain two or more aromatic rings. They are ubiquitous in nature and are both naturally occurring and man-made. The database for acenaphthene is very limited.

Pharmacokinetics

No data were found regarding the pharmacokinetics of acenaphthene.

Human Toxicological Profile

No data were found regarding the human toxicology of acenaphthene.

Mammalian Toxicological Profile

Adverse effects on the lungs, glands, and blood were observed in rats following aerosol administration of 12 mg/m^3 acenaphthene for 5 months (U.S. EPA, 1981).

Genotoxicity

Mutagenicity tests for acenaphthene were negative (U.S. EPA, 1981). Carcinogenicity tests were negative (IARC, 1983).

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Source: MADEP Residential Short Form

ANTHRACENE

General Background Information

Anthracene is a polycyclic aromatic hydrocarbon (PAH). PAHs are a class of compounds which are non-polar and contain two or more aromatic rings. They are ubiquitous in nature and are both naturally occurring and man-made. As a PAH, anthracene is found in tobacco smoke, certain foods, and the emissions from industrial or natural burning.

Pharmacokinetics

Little data were found regarding the pharmacokinetics of anthracene. The intestinal absorption of anthracene is less dependent on the presence of bile in the stomach than is the absorption of larger PAHs such as benzo(a)pyrene (Rahman et al, 1986).

Human Toxicological Profile

Anthracene is a skin irritant and allergen (Sax, 1984). Humans exposed to anthracene in an occupational setting may demonstrate skin disorders (Clement, 1985). Anthracene has been associated with gastrointestinal tract toxicity in humans (Badiali et al, 1985). However, the usefulness of this study is limited due to confounding factors. Hematopoietic toxicity has also been observed in cancer patients who have been treated with anthracene-containing chemotherapeutics (Falkson et al, 1985). No control groups and concomitant exposure to other ingredients in the therapeutic agents prevents any definitive conclusions.

Mammalian Toxicological Profile

A subchronic study where anthracene was administered to mice by gavage for at least 90 days found no treatment-related effects at doses up to 1000 mg/kg-day (USEPA, 1989). The data on the carcinogenicity of anthracene are considered inadequate by EPA (IRIS, 1991).

Genotoxicity

Tests for DNA damage, mutation, chromosome effects and cell transformation in a variety of eukaryotic cell preparations have shown negative results. The majority of tests using anthracene in prokaryotes are negative, but positive results are reported in one or two tests (ATSDR, 1990; IRIS, 1991).

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Source: MADEP Residential Short Form

BENZO[a]ANTHRACENE

General Background Information

Benzo[a]anthracene (BaA) is a member of the polycyclic aromatic hydrocarbons (PAH). PAHs are a class of non-polar compounds that contain two or more aromatic rings. They are ubiquitous in nature and are both naturally occurring and man-made. The overall database for benzo[a]anthracene is limited. Human exposures to BaA can come from the oral, inhalation or dermal routes. BaA is produced when gasoline or other organic material is burned. It is also found in cigarette smoke and cooked food. People most at risk from exposure to BaA are those in the coal tar and asphalt production industries, cooking plants, coal gasification plants, smoke houses and industrial plants that burn wood, trash, coal or oil.

Pharmacokinetics

BaA is absorbed by the dermal and oral routes. There is no information on absorption by inhalation. Biotransformation to reactive intermediates is necessary for toxicity (ATSDR, 1990). BaA accumulates in adipose tissue. The metabolism of BaA is similar to the metabolism of benzo[a]pyrene (Cooper et al., 1983). In brief, the aromatic ring is oxidized by arene oxides to form reactive intermediates. The reactive intermediates are subsequently hydrolyzed to diols (Sims and Grover, 1974). The diols are conjugated with glutathione and excreted.

Human Toxicological Profile

There are no reports directly correlating human exposure to BaA with the development of excess tumors.

Mammalian Toxicological Profile

The only toxicity endpoint that has been adequately studied for BaA is dermal carcinogenicity. There is some evidence that benz[a]anthracene is carcinogenic in laboratory animals by the oral route (Klein, 1963; Bock and King, 1959) and also by subcutaneous injection (IARC, 1973). BaA has been shown to cause skin tumors after dermal application (Bingham and Falk, 1969). Tumorigenicity of the diol epoxide metabolite has been shown (Levin et al., 1978) as well as the mutagenicity of the diol epoxide (Wood et al., 1977).

Genotoxicity

The metabolism of BaA is an essential event in producing genotoxic effects in both *in vitro* and *in vivo* biological test systems (ATSDR, 1990). The intermediates formed by BaA metabolism are reactive electrophiles which are capable of interacting with DNA.

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Source: MADEP Residential Short Form

BENZO[b]FLUORANTHENE

General Background Information

Benzo[b]fluoranthene (BbF) is a member of the class of compounds referred to as polycyclic aromatic hydrocarbons (PAHs). PAHs contain two or more aromatic rings. PAHs are ubiquitous in nature and are both naturally occurring and man-made. Exposure to BbF can come from air, water, or soil. As a PAH, BbF is present in the emissions from industrial plants that produce coal tar, cooking plants, asphalt production plants, and home heating with wood and coal. BbF is also present in charcoal-broiled foods and cigarette smoke (ATSDR, 1990).

Pharmacokinetics

No data on the absorption, distribution or excretion of BbF were identified. BbF is metabolized under *in vitro* incubation conditions to phenol and dihydrodiol metabolites (Amin et al., 1982). The general metabolic pathways elucidated for benzo(a)pyrene are also active on BbF (Cooper et al., 1983; Levin et al., 1982; Grover et al., 1986). The reactive metabolites associated with the tumorigenic effects of BbF may not be the diol epoxides (Amin et al., 1982; Amin et al., 1985). As for the other PAHs, the material excreted is expected to consist primarily of dihydrodiol and phenol conjugates (Grover et al., 1986).

Human Toxicological Profile

The database for human toxicity is very limited. There are no studies correlating exposure to BbF and cancer or systemic toxicity. The only data implicating BbF as a carcinogen come from carcinogenicity studies using a mixture of PAHs.

Mammalian Toxicological Profile

The database on the toxicity of BbF is limited. Intratracheal administration of BbF to rats resulted in an increase in respiratory tract tumors (Deutsch-Wenzel et al., 1983). BbF has caused skin tumors in mice following dermal application (Wynder and Hoffman, 1959). The skin tumor initiating ability of BbF has been demonstrated in mice using a standard initiation/promotion protocol with either croton oil or phorbol myristate acetate as a tumor promotor (Amin et al., 1985; LaVoie et al., 1979, 1982).

Genotoxicity

The genotoxicity of BbF has been shown equivocally in three *in vitro* studies. BbF has been shown to be mutagenic in *Salmonella typhimurium* in the presence of an exogenous rat-liver preparation (LaVoie et al., 1979). Mutagenic activity has been reported in another similar study (Hermann, 1981). Negative results were reported by Mossanda (1979). The results cannot support an unequivocal determination regarding the genotoxicity of BbF at this time.

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Source: MADEP Residential Short Form

BENZO[k]FLUORANTHENE

General Background Information

Benzo[k]fluoranthene (BkF) is a member of the class of compounds referred to as polycyclic aromatic hydrocarbons (PAHs). PAHs contain two or more aromatic rings. PAHs are ubiquitous in nature and are both naturally occurring and man-made. Exposure to BkF can come from air, water, or soil. As a PAH, BkF is present in the emissions from industrial plants that produce coal tar, cooking plants, asphalt production plants, and home heating with wood and coal. BkF is also present in charcoal-broiled foods and cigarette smoke (ATSDR, 1990).

Pharmacokinetics

No data on the absorption, distribution or excretion of BkF were identified. BkF is believed to be metabolized to phenol and dihydrodiol metabolites (ATSDR, 1990). The general metabolic pathways elucidated for benzo[a]pyrene are believed to be active on BkF. As for the other PAHs, the material excreted is expected to consist primarily of dihydrodiol and phenol conjugates (Levin et al., 1982; Cooper et al., 1983; Grover et al., 1986).

Human Toxicological Profile

The database for human toxicity is very limited. There are no studies correlating exposure to BkF and cancer or systemic toxicity. The only data implicating BkF as a carcinogen come from carcinogenicity studies using a mixture of PAHs.

Mammalian Toxicological Profile

The database on the toxicity of BkF is limited. The skin tumor initiating ability of BkF has been demonstrated in mice using a standard initiation/promotion protocol with either croton resin or phorbol myristate acetate as tumor promotors (Van Duuren et al., 1966; LaVoie et al., 1982). Chronic dermal application of benzo[k]fluoranthene to mice resulted in no skin tumors, suggesting that BkF alone is not a complete carcinogen (Wynder and Hoffman, 1959).

Genotoxicity

The genotoxicity of BkF has not been documented in *in vitro* studies. In vivo, a single topical application of BkF was reported to bind to DNA in CD-1 mouse skin (Weyland et al., 1987). Covalent binding of chemicals to DNA can result in strand breaks and DNA damage, ultimately leading to mutations (ATSDR, 1990).

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Source: MADEP Residential Short Form

BENZO[g,h,i]PERYLENE

General Background

Benzo[g,h,i]perylene is a member of the polyaromatic hydrocarbons (PAH). PAHs constitute a class of non-polar compounds that contain two or more aromatic rings. They are ubiquitous in nature and are both naturally occurring and man-made. The data regarding benzo[g,h,i]perylene are limited. As a PAH, it is found in food (charcoal broiled meats), vegetables, tobacco smoke and soot (U.S. EPA, 1980). Exposure occurs by inhalation, ingestion and by dermal contact.

Pharmacokinetics

No data were found regarding the pharmacokinetics of benzo[g,h,i]perylene.

Human Toxicological Profile

No data were found regarding the human toxicology of benzo[g,h,i]perylene.

Mammalian Toxicological Profile

No data were found regarding the mammalian toxicity of benzo[g,h,i]perylene.

Genotoxicity

No data were found regarding the genotoxicity of benzo[g,h,i]perylene.

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Source: MADEP Residential Short Form

BENZO[a]PYRENE

General Background Information

Benzo[a]pyrene (BaP) is a member of the class of compounds generally referred to as polyaromatic hydrocarbons (PAH). PAHs contain two or more aromatic rings. They are ubiquitous in nature and are both naturally occurring and man-made. BaP is a component of fossil fuels and is produced from incomplete combustion of organic compounds. BaP and other PAHs are found in coal tar, creosote oils and pitches formed from distillation of coal tars (ATSDR, 1990).

Pharmacokinetics

BaP is readily absorbed by dermal, inhalation and oral routes (see section on Relative Absorption Factors). Distribution of BaP is rapid among several tissues. Following inhalation exposure to ^{3}H labeled BaP, maximum levels of radioactivity were found in the liver, esophagus, small intestine and blood after 30 minutes. After 12 hours, maximum levels were found in the cecum, stomach and large intestine (Sun et al., 1982). This and other studies provide evidence for the enterohepatic circulation of BaP metabolites.

Mammalian metabolism of BaP follows the mechanism established for smaller aromatic compounds (Williams, 1959). There is an initial oxidation of a double bond on one of the rings to an arene oxide. The oxide is then hydrolyzed to the diol. Oxidations may occur at multiple sites on the BaP molecule. Phase II metabolism is considered the detoxication pathway and involves the conjugation of the activated Phase I metabolites with easily eliminated substrates such as glutathione, glucuronide or sulfate (Cooper et al., 1983). In addition to being conjugated, the diol intermediate can undergo (1) further oxidation to several uncharacterized metabolites via the P-450 monooxygenase system, (2) spontaneous rearrangement to the phenol or (3) hydration to the trans-diols through a reaction catalyzed by epoxide hydrolase (Cooper et al., 1983). BaP 7,8-diol-9,10-epoxide has been established as an ultimate carcinogen (ATSDR, 1990). The primary route of excretion of BaP is through the feces. BaP undergoes first-pass metabolism and is reabsorbed via enterohepatic circulation (Chipman et al., 1982). Rats exposed by gavage to ^{14}C labeled BaP in peanut oil excreted up to 85% in the feces. Excretion in the urine was 1 to 3% of the administered dose (Hecht et al., 1979).

Human Toxicological Profile

The database for the toxicological effects of BaP on humans, separate from PAHs, is limited. Toxic effects attributable to mixtures of PAHs include a variety of skin lesions and non-cancer lung diseases such as bronchitis (IARC, 1973).

Mammalian Toxicological Profile

BaP is a moderately potent experimental carcinogen in numerous species by many routes of exposure (IARC, 1983). Mice exposed to doses of BaP ranging from 1.5 to 400 mg/kg/d developed benign and malignant tumors of the forestomach (Hartwell, 1951; Thompson, 1971). Acute intragastric doses of 50 to 67 mg/kg of BaP have been shown to elicit pulmonary adenomas and forestomach papillomas in mice (Sparnins et al., 1986; Wattenberg and Beuding, 1986). Intermittent gavage exposure of mice to 50 to 67 mg/kg BaP resulted in 100% forestomach and pulmonary tumor incidences at 30 weeks of age (Sparnins et al., 1986; Wattenberg and Leong, 1970). Mice fed BaP at concentrations equivalent to 33.3 mg/kg/d exhibited gastric neoplasms following two or more days of consumption. However, lower concentrations of BaP (equivalent to 13.3 mg/kg/d) administered for up to 7 days did not produce any forestomach tumors (Neal and Rigdon, 1967). Hamsters have developed papillomas and carcinomas of the alimentary tract following gavage or dietary exposure to BaP (Chu and Malmgrem, 1965). A single oral dose of 100 mg BaP (200mg/kg) produced mammary tumors in 88% of female Sprague-Dawley rats (Huggins and Yang, 1962). A 77% mammary tumor incidence was observed 90 weeks after a single oral dose of BaP of 50 mg (100mg/kg) was administered to rats (McCormick, 1981).

Genotoxicity

There are no studies relating exposure to BaP in humans to genotoxicity. In short-term *in vitro* and *in vivo* genetic toxicology tests, BaP has been shown to be a potent genotoxic agent when metabolically activated. In mice, oral exposure to 10 mg/kg BaP produced gene mutations in the mouse coat color spot test (Davidson and Dawson, 1976,1977). BaP shows positive mutagenic activity, in vitro, in several strains of *Salmonella typhimurium* in the presence of either rodent microsomes or hepatocytes for exogenous metabolic activation (ATSDR, 1990). Epidemiological studies have shown increased incidences of lung cancer in humans exposed via inhalation to mixtures of PAHs which include BaP (ATSDR, 1990).

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Source: MADEP Residential Short Form

CHRYSENE

General Background Information

Chrysene is one of the polycyclic aromatic hydrocarbon (PAH) compounds which are formed during the combustion of organic material. Chrysene often exists in particulate form, adsorbing to existing particulate material in air. Human exposure can occur in the workplace (coal and asphalt production plants, cooking plants, smoke houses) or in the environment due to chrysene contamination of air, food, soil and water (ATSDR, 1990).

Pharmacokinetics

Chrysene can be absorbed by all routes of exposure (see section on Relative Absorption Factors). Its absorption is believed to be qualitatively similar to benzo[a]pyrene (ATSDR, 1990). Following absorption, chrysene distributes to all organs, reaching the highest concentration in tissues with large fat content (adipose tissue, mammary tissue, brain) (Modica et al., 1983). Chrysene undergoes metabolic biotransformation mediated by the mixed function oxidase enzyme system to form reactive intermediates hypothesized to be responsible for its toxicity. The major metabolites include trans-dihydrodiols, phenols, diol epoxides and triol epoxides (Thakker et al., 1985). The reactive metabolites are conjugated and excreted primarily in feces (Schlede et al., 1970).

Human Toxicological Profile

There is no information available on threshold toxic effects of chrysene in humans. Since it is structurally similar to benzo[a]pyrene, it would be expected to produce effects similar to B[a]P following acute or chronic exposure (see Toxicity Profile on Benzo[a]pyrene).

Mammalian Toxicological Profile

There is no information available on threshold toxic effects of chrysene in animals. Since it is structurally similar to benzo[a]pyrene, it would be expected to produce effects similar to B[a]P following acute or chronic exposure (see Toxicity Profile for Benzo[a]pyrene).

Genotoxicity

The genotoxicity of chrysene has been evaluated in in vivo and in vitro cytogenetic tests. Chrysene produced weak positive results in bacterial mutation assays, human epithelial mutation studies, cell transformation assays and in vivo cytogenetic studies (Waters et al., 1987). Metabolism of chrysene is essential to produce the observed positive responses. Chrysene is not genotoxic in all test systems, however, it is believed to be a weak mutagen (ATSDR, 1990). The carcinogenicity of chrysene has not been adequately studied. There are no reports directly correlating human chrysene exposure and tumor development. There is limited evidence that chryesene is a skin carcinogen in animals following long-term dermal application (Wynder and Hoffmann, 1959; Hecht et al., 1974).

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Source: MADEP Residential Short Form

FLUORANTHENE

General Background Information

Fluoranthene is a member of the polyaromatic hydrocarbons (PAH). PAHs constitute a class of non-polar compounds that contain two or more aromatic rings. They are ubiquitous in nature and are both naturally occurring and man-made. Fluoranthene has been detected in food, cigarette smoke, and smoke from industrial and natural burning.

Pharmacokinetics

No data were found regarding the pharmacokinetics of fluoranthene.

Human Toxicological Profile

The database for the toxicological effects of fluoranthene on humans, separate from other PAHs, is limited. Toxic effects attributable to mixtures of PAHs include a variety of skin lesions and non-cancer lung diseases such as bronchitis (IARC, 1973).

Mammalian Toxicological Profile

The database on the toxicity of fluoranthene is limited. A 13 week subchronic study where CD-1 mice were gavaged with up to 500 mg/kg-day of fluoranthene indicated nephropathy, increased liver weights, hematological alterations and clinical effects (EPA, 1988). A developmental study in which fluoranthene was administered once via intraperitoneal injection to pregnant mice reported only an increased rate of embryo resorption (Irvin and Martin, 1987).

Chronic dermal application of up to 1 percent fluoranthene to the backs of mice did not induce skin tumors following lifetime application (Hoffman et al, 1972; Horton and Christian, 1974; and Wydner and Hoffman, 1959a). Fluoranthene is not a complete carcinogen (ATSDR, 1990) and does not exhibit iniation activity (Hoffman et al, 1972).

Genotoxicity

There is some evidence that fluoranthene is genotoxic (ATSDR, 1990). Genotoxic effects have been reported in human cells with exogenous metabolic activation, but negative results were recorded without metabolic activation.

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Source: MADEP Residential Short Form

FLUORENE

General Background Information

Fluorene is a member of the polyaromatic hydrocarbons (PAH). PAHs constitute a class of non-polar compounds that contain two or more aromatic rings. They are ubiquitous in nature and are both naturally occurring and man-made. The data on fluorene are very limited. Low levels of (5 to 67 ug/kg) have been detected in smoked meats (U.S. EPA, 1982).

Pharmacokinetics

No data were found regarding the pharmacokinetics of fluorene.

Human Toxicological Profile

The database for the toxicological effects of fluoranthene on humans, separate from other PAHs, is limited. Toxic effects attributable to mixtures of PAHs include a variety of skin lesions and non-cancer lung diseases such as bronchitis (IARC, 1973).

Mammalian Toxicological Profile

Limited information is available on the threshold effects of fluorene. An EPA study (EPA,1989) indicated that CD-1 mice exposed by gavage to up to 500 mg/kg-day of fluorene showed hypoactivity as well as a decrease in red blood cell count and packed cell volume and hemoglobin. Increases in absolute and relative liver, spleen and kidney weights was also observed. Gershbein (1975) reported that partially hepatectomized rats fed a diet of 180 mg/kg-day of fluorene for 10 days showed a statistically significant increase in liver regeneration, which is indicative of the ability to induce a proliferative response.

Fluorene is not reported to be a complete skin carcinogen (ATSDR, 1990). It was inactive as a tumor initiator when an estimated total dose of 1.0 mg was applied prior to the application of tetradecanoyl phorbol acetate (LaVoie et al, 1980).

Genotoxicity

There is no evidence that fluorene is genotoxic, but genotoxicity has been studied only in a few in vitro assays (ATSDR, 1990).

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Source; MADEP Residential Short Form

INDENO[1,2,3-cd]PYRENE

General Background Information

Indeno[1,2,3,-cd]pyrene is a member of the polyaromatic hydrocarbons (PAH). PAHs constitute a class of non-polar compounds that contain two or more aromatic rings. They are ubiquitous in nature and are both naturally occurring and man-made. Indeno[1,2,3-cd]pyrene is present in cigarette smoke (IARC, 1983) as well as emissions from industrial stacks.

Pharmacokinetics

No data were found regarding the pharmacokinetics of indeno[1,2,3-cd]pyrene. However, its metabolism should be similar to another non-alternant PAH, benzo(b)fluoranthene (ATSDR, 1990).

Human Toxicological Profile

The database for the toxicological effects of indeno[1,2,3-cd]pyrene on humans, separate from other PAHs, is limited. Toxic effects attributable to mixtures of PAHs include a variety of skin lesions and non-cancer lung diseases such as bronchitis (IARC, 1973).

Mammalian Toxicological Profile

Studies on laboratory animals have demonstrated that indeno[1,2,3-cd]pyrene can induce skin tumors (i.e. it is a complete carcinogen) following dermal exposure (ATSDR, 1990). It has tumor initiating activity, but is not as potent as benzo(b)fluoranthene (Rice et al, 1985).

Carcinogenic PAHs as a group are immunosuppressant, with the degree of suppression correlated with the degree of potency (ATSDR, 1990)

Genotoxicity

In test systems using non-human cells, indeno[1,2,3-cd]pyrene was found to be genotoxic (ATSDR 1990).

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Source: MADEP Residential Short Form

PHENANTHRENE

General Background Information

Phenanthrene is a member of the polyaromatic hydrocarbons (PAH). PAHs constitute a class of non-polar compounds that contain two or more aromatic rings. They are ubiquitous in nature and are both naturally occurring and man-made. The database on the potential health effects of phenanthrene is limited.

Pharmacokinetics

Little data are available regarding the pharmacokinetics of phenanthrene. The intestinal absorption of phenanthrene is less dependent on the presence of bile in the stomach than is the absorption of the larger PAHs (such as benzo(a)pyrene) (Rahman et al, 1986).

Human Toxicological Profile

Phenanthrene has been shown to be a skin photosensitizer in humans (Sax, 1984).

Mammalian Toxicological Profile

Phenanthrene has a reported LD 50 of 700 mg/kg in mice (Simmon et al., 1979). Rats injected intraperitoneally evidenced liver effects (Yoshikawa et al, 1987).

There is equivocal evidence for cancer from dermal application of phenanthrene in rats (IARC, 1983). Phenanthrene is not a complete skin carcinogen (ATSDR, 1990). It is neither an initiator (LaVoie et al, 1981; Roe, 1962) nor a promoter (Roe and Grant, 1964). Higgins and Yang (1962) reported no tumor production within two months after the ingestion of 200 mg of phenanthrene by rats.

Genotoxicity

There are limited data that suggest that phenanthrene is mutagenic (Wood et al., 1979). However, the majority of tests are negative (ATSDR, 1990).

REFERENCES

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Source: MADEP Residential Short Form

PYRENE

General Background Information

Pyrene is a member of the polyaromatic hydrocarbons (PAH). PAHs constitute a class of non-polar compounds that contain two or more aromatic rings. They are ubiquitous in nature and are both naturally occurring and man-made. As with many of the other PAHs, pyrene has been detected in charbroiled meats and shellfish (U.S. EPA, 1982). It is found in tobacco smoke, industrial stack smoke, and smoke from forest fires.

Pharmacokinetics

No data were found regarding the pharmacokinetics of pyrene.

Human Toxicological Profile

Pyrene is reported to be a skin irritant (Sax, 1984).

Mammalian Toxicological Profile

Rats given 150 mg/kg of pyrene had changes in blood chemistry, liver and kidney damage (USEPA, 1982). A 1989 EPA study (EPA, 1989) reported nephropathy and decreased kidney weights in mice exposed to 125 mg/kg-day of pyrene by gavage for 13 weeks.

Mouse skin painting assays indicate that pyrene is neither a complete skin carcinogen, nor an initiating agent (ATSDR, 1990, IRIS, 1991).

Genotoxicity

The majority of genotoxic tests of pyrene are negative. Positive results have been recorded in Salmonella typhimurium mutagenicity tests and in in vitro mammalian cell systems (ATSDR, 1990).

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Source: MADEP Residential Short Form

BARIUM

Barium is a divalent alkaline-earth metal found only in combination with other elements in nature. The most important of these combinations are the peroxide, chloride, sulfate, carbonate, nitrate, and chlorate. The pure metal oxidizes readily and reacts with water emitting hydrogen. The most likely source of barium in the atmosphere is from industrial emissions. Barium compounds are used by the oil and gas industries to make drilling muds. Drilling muds make it easier to drill through rock by keeping the drill bit lubricated. They are also used to make paint, bricks, tiles, glass, and rubber. A barium compound (barium sulfate) is sometimes used by doctors to perform medical tests and to take barium-rays of the stomach. Since it is usually present as a particulate form, it can be removed from the atmosphere by wet precipitation and deposition. Due to the element's tendency to form salts with limited solubility in soil and water, it is expected to have a residence time of hundreds of years and is not expected to be very mobile. Trace amounts of barium were found in more than 99% of the surface waters and finished drinking water samples across the United States.

The soluble salts of barium are toxic in mammalian systems. They are absorbed rapidly from the gastrointestinal tract and are deposited in the muscles, lungs, and bone. Inhalation exposure of human populations to barium-containing dust can result in a benign pneumoconiosis called "baritosis." At low doses, barium acts as a muscle stimulant and at higher doses affects the nervous system eventually leading to paralysis. Acute and subchronic oral doses of barium cause vomiting and diarrhea, followed by decreased heart rate and elevated blood pressure. Higher doses result in cardiac irregularities, weakness, tremors, anxiety, and dyspnea. A drop in serum potassium may account for some of the symptoms. Death can occur from cardiac and respiratory failure. Acute doses around 0.8 grams can be fatal to humans.

The Department of Health and Human Services, the International Agency for Research on Cancer, and the Environmental Protection Agency (EPA) have not classified barium as to its human carcinogenicity.

Profile obtained from Risk Assessment Information System (RAIS), U.S. Department of Energy (DOE), Office of Environmental Management, Oak Ridge Operations (ORO) Office.
http://risk.lsd.ornl.gov/tox/ profiles/Barium_ragsa.shtml

CADMIUM

General Background Information

Cadmium typically exists in the environment as a salt of the +2 valence state or as a metal. It forms no stable organic compounds. Cadmium releases are generally associated with mining, smelting, manufacturing operations, and from the disposal of alkaline batteries containing cadmium (Doull, 1980; U.S. EPA, 1981).

Pharmacokinetics

Cadmium is absorbed by all routes of exposure (see section on Relative Absorption Factors). Absorption through the gastrointestinal tract is low, respiratory absorption more efficient and dermal absorption relatively insignificant (ATSDR, 1989). Absorbed cadmium is widely distributed throughout the body, with the major portion of the body burden located in liver and kidney (Sumino et al., 1975). The distribution of cadmium is linked to the distribution of metallothionein, a low-moleculer-weight protein, rich in cadmium-binding sites. Cadmium is not known to undergo any direct metabolic conversions in vivo. The principle excretory route for absorbed cadmium is urinary. Excretion is slow, accounting for the long half-life of cadmium in the body (17-38 years) (ATSDR, 1989).

Human Toxicological Profile

Cadmium is a local respiratory tract irritant. Systemic symptoms occur in a few hours after an acute exposure to cadmium dust or fumes. Upper respiratory tract irritation is followed by coughing, chest pain, sweating, and chills. These symptoms resemble nonspecific upper respiratory infection (Sittig, 1985). Within 24 hours severe pulmonary irritation may develop, with progressively increasing pain in the chest, dyspnea, pulmonary edema, cough, and generalized weakness. Chronic exposure to cadmium fumes may result in emphysema-like lung damage (Sittig, 1984). Renal dysfunction may ensue (Friberg, 1950). Bernard and Lauwerys (1984) observed that the gastrointestinal tract is adversely affected by acute oral exposure with such symptoms as nausea, vomiting, salivation, abdominal pain, cramps, and diarrhea. The principal effects of chronic cadmium exposure are osteomalacia and osteoporosis (Itai Itai disease) secondary to glomerular and tubular necrosis in the kidney. The Itai Itai ("ouch-ouch") disease is endemic areas in Japan, which have been contaminated with mining wastes containing cadmium. Victims display the osteomalacia and osteoporosis as primary symptoms, as well as protein, sugar and amino acids not normally found in the urine. Other chronic effects include immunosuppression and decreases in measures of respiratory fitness (ventilation capacity, vital capacity, forced expiratory volume, etc.) (U.S. EPA, 1981).

Mammalian Toxicological Profile

Several subchronic and chronic oral toxicity studies have been conducted in animals. Koller et al. (1975) and Fitzhugh and Meiller (1941) conducted feeding studies using mice and rats, respectively. The first group of researchers reported immunological impact manifested by a decrease in the number of lymphocytes secreting antibodies (to sheep red blood cells) as well as some renal effects. The second set of authors observed hematological symptoms expressed as marked anemia. Yuhas et al. (1979) conducted a drinking water study using Sprague-Dawley male rats. Decreased weight gain was observed at the highest dose level. In addition, the authors identified increases in cadmium content and decreases in the zinc content of the bone. Renal dysfunction or otherwise generalized adverse effects on the kidney have been reported in a number of long-term cadmium ingestion studies (Friberg et al., 1974; Kijikawa et al., 1981; Schroeder et al., 1964; Kanisawa and Schroder, 1969). In addition, the latter two research groups have observed renal and cardiac arteriosclerosis.

Genotoxicity

Results of mutagenicity tests in bacteria and yeasts have been inconclusive. Positive results have been obtained in mutation assays in Chinese hamster cells and in mouse lymphoma cells. Conflicting results have been obtained in assays of chromosomal aberrations in human lymphocytes treated in vitro or obtained from exposed workers. Cadmium treatment in vitro or in vivo appears to result in aneuploidy in germ cells of mice or hamsters (ATSDR, 1989). Reports of elevated prostate cancer in cadmium workers have been evaluated as insufficient evidence of the carcinogenic action of the compound (U.S. EPA, 1985), but the elevated risk of lung cancer observed by Thun et al. (1985) is more convincing. Thus, the carcinogenic potential of inhaled cadmium should be viewed as limited, but suggestive. Although ingestion of cadmium may result in kidney effects, no carcinogenic response has been demonstrated for this route.

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Source: MADEP Residential Short Form

CHROMIUM

General Background Information

Chromium is used in plating for corrosion resistance and decorative purposes (appliances, tools, automobiles, etc.), in the manufacture of alloys (including stainless steel and heat resistant alloys), and in printing, dyeing, photography, tanning, and numerous other industrial applications (ATSDR, 1989).

Pharmacokinetics

Absorption studies of chromium compounds indicate that it is absorbed by all routes of exposure (see section on Relative Absorption Factors) with chromium (VI) compounds being more readily absorbed than chromium (III) compounds. Once absorbed, chromium is rapidly distributed to all organs, including the developing fetus. Chromium VI is readily reduced to Cr III in vivo. Excretion occurs primarily through the kidneys via urine (ATSDR, 1989).

Human Toxicological Profile

In humans, the respiratory tract is the primary system of concern for chromium toxicity. Renal damage has also been observed. Hexavalent chromium has been shown to be highly toxic, causing ulceration of nasal mucosa and carcinoma of the lung following long-term occupational exposure. Cases of acute poisoning in man have been reported from the medical use of chromic acid.

Chronic exposures of workers in chromium-related industries have been observed to result in skin and nasopharyngeal irritations. Both Cr(III) an Cr(VI) can cause allergic contact dermatitis and irritation (Samitz and Shrager, 1966). Chromium was shown to be an allergen in recurrent contact dermatitis of the feet (Correia and Brandao, 1986). Hexavalent forms are responsible for effects on the upper respiratory system, including ulceration and perforation of the nasal septum, chronic rhinitis, and pharyngitis. Lindberg and Hedenstierna (1983) reported that subjective and objective evidence of adverse nasal effects were found at exposure levels of 2 to 20 ug Cr(VI)/m^3 but not at less than 1 ug/m^3. They also reported that workers exposed to 2 to 20 ug Cr(VI)/m^3 had slight transient decreases in measures of pulmonary mechanics (e.g., forced vital capacity, FVC) with recovery (no changes) seen by two (non-exposed) days later.

Mammalian Toxicological Profile

In laboratory animals, Cr compounds are of low oral acute toxicity. Hexavalent chromium is more acutely toxic than Cr(III), with kidney failure being the primary symptom. The LC_{50} in rats for inhalation of sodium chromate(VI) was reported as 33 mg Cr/m^3/4H, and the LD_{50}'s for oral and dermal exposures were given as 16.7 mg Cr/kg and 514 mg Cr/kg, respectively (Gad et al., 1986). Chromium was found to localize in the proximal renal tubules when intraperitoneal doses of potassium dichromate were administered to rats 5 times weekly for 8 months (Berry et al., 1978). Low level hexavalent chromium exposure increases respiratory defense mechanisms while they are inhibited by long-term, high level exposure (Glaser et al., 1985). Chromium salts have been shown to be teratogenic and embryotoxic in mice and hamsters following intravenous or intraperitoneal injection. However, these are unnatural routes of administration for assessing effects of environmental exposures, and further research is needed (U.S. EPA, 1984).

Genotoxicity

Both Cr(III) and Cr(VI) have been shown to interact with DNA in bacterial systems. Cr(III) is generally considered to be a relatively inactive genotoxic agent since it is unable to cross cell membranes. It was recently shown, however, to cause chromosomal aberrations in human lymphocytes (Friedman et al., 1987).

Hexavalent chromium has consistently caused transformations and mutations in a wide variety of in vitro assays (Bianchi and Lewis, 1985). Chromosomal damage has been observed in lymphocytes cultured from workers exposed to chromium. The epidemiologic studies of respiratory cancer in chromate production workers provide the bulk of the evidence for chromium carcinogenicity. Studies of chromate production facilities in the United States, Great Britain, and Japan have all found an association between occupational exposure to chromium and lung cancer (U.S. EPA, 1984). Workers were exposed to both Cr(VI) and Cr(III), and it is unclear whether Cr(VI) alone is the etiologic agent or whether Cr(III) is implicated as well. The U.S. EPA (1984) concluded that in rats, only calcium chromate had consistently produced lung tumors by several routes of administration, and that other Cr(VI) compounds produced local sarcomas or lung tumors in rats at the site of administration (subcutaneous, intraperitoneal, intermuscular, intrabroncheal, and intratracheal). Trivalent chromium compounds have not been found to be carcinogenic by any route of administration, but these compounds have not been studied as extensively.

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Source: MADEP Residential Short Form.

LEAD

General Background Information

Lead is used extensively in the manufacture of storage batteries and was used in gasoline and paint. Lead is also a natural constituent of many soils, for which concentrations normally range from 10 to 30 mg lead per kilogram of soil (U.S. EPA, 1980).

Pharmacokinetics

Lead can be absorbed by the oral, inhalation or dermal exposure routes (see section on Relative Absorption Factors). Gastrointestinal absorption of lead varies considerably depending upon chemical form, dietary intake, and age (Forbes and Reina, 1974; Barltrop and Meek, 1975). The deposition and absorption of inhaled lead depends upon particle size, chemical form and the rate and depth of breathing (Randall et al., 1975; Nozaki, 1966; Chamberlain et al., 1975). Once absorbed, lead is distributed to the various organs of the body, with most distribution occurring into mineralized tissues (ATSDR, 1990). Placental transfer to the developing fetus is possible (Bellinger et al., 1987). Inorganic lead is not known to be biotransformed within the body. Absorbed lead is excreted via the urinary or fecal routes (ATSDR, 1990)

Human Toxicological Profile

Cases of acute lead poisoning in humans are not common and have not been studied in experimental animals as thoroughly as chronic lead poisoning. Symptoms of acute lead poisoning from deliberate ingestion by humans may include vomiting, abdominal pain, hemolysis, liver damage, and reversible tubular necrosis (U.S. EPA, 1984). Subacute exposures in humans reportedly may produce a variety of neurological effects including dullness, restlessness, irritability, poor attention span, headaches, muscular tremor, hallucinations, and loss of memory. Nortier et al., (1980) report encephalopathy and renal damage to be the most serious complications of chronic toxicity in man and the hematopoietic system to be the most sensitive. For this reason, most data on the effects of lead exposure in humans are based upon blood lead levels. The effects of lead on the formation of hemoglobin and other hemoproteins, causing decreased levels, are reportedly detectable at lower levels of lead exposure than in any other organ system (Betts et al., 1973). Peripheral nerve dysfunction is observed in adults at levels of 30 to 50 µg/dL-blood. Children's nervous systems are reported to be affected at levels of 15 µg/dL-blood and higher (Benignus et al., 1981). In high doses, lead compounds may potentially cause abortions, premature delivery, and early membrane rupture (Rom, 1976).

Mammalian Toxicological Profile

Acute oral lethal doses of lead in animals depend upon chemical form, but generally range from 500 to 30,000 mg/kg. Several reproduction studies on the effects of subchronic oral exposure to lead in rats have been conducted (Kimmel et al., 1976; Grant et al., 1980; Fowler et al., 1980). These studies report that lead acetate administered in drinking water at various concentrations caused depressed body weights at 50 and 250 mg-Pb/L water, histological changes in the kidneys of offspring, cytokaryomegaly of the tubular epithelial cells of the inner cortex at concentrations greater than or equal to 25 mg/L and postnatal developmental delays at 50 to 250 mg/L. Higher oral doses of lead may result in decreased fertility and fetotoxic effects in a variety of species (Hilderbrand et al., 1973). A reduction in the number of offspring of rats and mice exposed to 25 mg Pb/L drinking water with a chromium deficient diet was reported by Schroeder et al. (1970). Chronic oral exposure of female Long-Evans rats to lead (5 mg/PB/L-water) reportedly resulted in slight effects on tissue excitability, systolic blood pressure, and cardiac ATP concentrations (Kopp et al., 1980a,b).

Genotoxicity

Results of *in vitro* studies with human lymphocyte cultures using lead acetate were nearly equally positive and negative. Results of in vivo tests are also contradictory but suggest that lead may have an effect on chromosomes (sister chromatid exchange).

Results for gene mutations, DNA modification, and recombinations in various microorganisms using lead acetate, lead nitrate and lead chloride were consistently negative with or without metabolic activation. Lead chloride has been reported to inhibit both DNA and RNA synthesis. In *in vitro* mammalian test systems, lead acetate gave conflicting results.

No epidemiological data regarding the oral carcinogenic potential of lead could be located in the available literature. Chronic inhalation may result in a statistically significant increase in deaths due to tumors in the digestive organs and respiratory systems in lead smelter workers and battery plant workers (Kang et al., 1980). Several studies have reported tumor formation in experimental animals orally administered specific lead salts, not normally ingested by humans (Zawirska and Medras, 1972; Boyland et al., 1962; Ito, 1973). The carcinogenicity of inhaled lead in experimental animals could not be located in the available literature. The U.S. EPA has classified lead and lead compounds as Group B2 - Probable Human Carcinogens.

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Source: MADEP Residential Short Form

MERCURY

General Background Information

Mercury has been used in the past for medicinal purposes (Gosselin et al., 1984). There are a number of occupations associated with mercury exposure, particularly through inhalation. These include mining, smelting, chloralkali production, and the manufacture of mercury-containing products such as batteries, measuring devices (thermometers) and paints. Mercury has also been used agriculturally as a seed and cereal protectant and as a fungicide.

Pharmacokinetics

The pharmacokinetics and pharmacodynamics of mercury depend largely on its chemical form, organic, inorganic or elemental. Absorption efficiencies vary depending on route of exposure and chemical form (see section on Relative Absorption Factors). Distribution, metabolism and excretion depend largely on the lipid solubility, ionization state and molecular size of the specific chemical form (ATSDR, 1989).

Human Toxicological Profile

Exposure to most forms of mercury is associated with a high degree of toxicity. Elemental (metallic) mercury causes behavioral effects and other nervous system damage. Inorganic mercury salts do not generally reach the brain, but will produce kidney damage. Divalent (mercuric) mercury is substantially more toxic in this regard than the monovalent (mercurous) form. Organic mercury compounds are also toxic. Symptoms of chronic mercury poisoning can be both neurological and psychological in nature as the central nervous system is the primary target organ. Hand and finger tremors, slurred or scanning speech patterns, and drunken, stupor-like (ataxic) gait are some motor-control impairments that have been observed in chronic mercurial toxicity. Visual disturbances may also occur, and the peripheral nervous system may be affected. A psychological syndrome known as erethism is know to occur. It is characterized by changes in behavior and personality including depression, fearfulness, restlessness, irritability, irascibility, timidity, indecision, and early embarrassment. Advanced cases may also experience memory loss, hallucination, and mental deterioration.

Mammalian Toxicological Profile

In a study by Mitsumori et al. (1981), male and female mice were fed methyl mercury chloride in their diet for up to 78 weeks. Most of the high dose group died from neurotoxicity before the 26th week. Renal tumors developed in 13 of 16 males in the intermediate dosage group by 53 weeks while only 1 male in the control group developed tumors. No renal tumors occurred in exposed or control females. Studies on rats have reported similar effects such as damage to kidneys and the peripheral nervous system (U.S. EPA, 1980). Mice treated with alkyl mercury phosphate were reported to have an increased frequency of offspring with cleft palates (Oharazawa, 1968) while mice treated with methylmercury had offspring with significantly lowered birth weights and possible neurological damage (Fujita, 1969). No adequate epidemiological studies exist on the teratogenic effects of methylmercury on humans (U.S. EPA, 1980).

Genotoxicity

Skerfving et al. (1974) reported a statistical relationship between chromosome breaks and concentrations of methyl mercury in the blood of Swedish subjects on fish diets. Concentrations were reported to be from 14-116 ng Hg/ml in the blood of exposed subjects and from 3-18 ng/ml in nonexposed subjects.

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Source: MADEP Residential Short Form

SELENIUM (CAS No. 7782-49-2)

General Background Information

Selenium occurs in several valence states: -2 (hydrogen selenide, sodium selenide, dimethyl selenium, trimethyl selenium, and selenoamino acids such as selenomethionine; 0 (elemental selenium); +4 (selenium dioxide, selenious acid, and sodium selenite); and +6 (selenic acid and sodium selenate). Toxicity of selenium varies with valence state and water solubility of the compound in which it occurs. The latter can affect gastrointestinal absorption rates.

Selenium is an essential trace element important in many biochemical and physiological processes including the biosynthesis of coenzyme Q (a component of mitochondrial electron transport systems), regulation of ion fluxes across membranes, maintenance of the integrity of keratins, stimulation of antibody synthesis, and activation of glutathione peroxidase (an enzyme involved in preventing oxidative damage to cells). Recommended human dietary allowances (average daily intake) for selenium are as follows: infants up to 1 year, 10-15 µg; children 1-10 years, 20-30 µg; adult males 11-51+ years, 40-70 µg; adult females 11-51+ years, 45-55 µg; pregnant or lactating women, 65-75 µg. There appears to be a relatively narrow range between levels of selenium intake resulting in deficiency and those causing toxicity.

Exposure Potential

Gastrointestinal absorption in animals and humans for various selenium compounds ranges from about 44% to 95% of the ingested dose (Thomson and Stewart, 1974; Bopp et al., 1982; Thomson, 1974). Respiratory tract absorption rates of 97% and 94% for aerosols of selenious acid have been reported for dogs and rats, respectively (Weissman et al., 1983; Medinsky et al., 1981). Selenium is found in all tissues of the body; highest concentrations occur in the kidney, liver, spleen, and pancreas (Schroeder and Mitchener, 1971a; Schroeder and Mitchener, 1972; Jacobs and Forst, 1981a; Julius et al., 1983; Shamberger, 1984; Echevarria et al., 1988). Excretion is primarily via the urine (0-15 g/L); however, excretory products can also be found in the feces, sweat, and in expired air.

Human Toxicity

In humans, acute oral exposures can result in excessive salivation, garlic odor to the breath, shallow breathing, diarrhea, pulmonary edema, and death (Civil and McDonald, 1978; Carter, 1966; Koppel et al., 1986). Other reported signs and symptoms of acute selenosis include tachycardia, nausea, vomiting, abdominal pain, abnormal liver function, muscle aches and pains, irritability, chills, and tremors. Acute toxic effects observed in animals include pulmonary congestion, hemorrhages and edema, convulsions, altered blood chemistry (increased hemoglobin and hematocrit); liver congestion; and congestion and hemorrhage of the kidneys (Smith et al., 1937; Anderson and Moxon, 1942; Hopper et al., 1985).

General signs and symptoms of chronic selenosis in humans include loss of hair and nails, acropachia (clubbing of the fingers), skin lesions (redness, swelling, blistering, and ulcerations), tooth decay (mottling, erosion and pitting), and nervous system abnormalities attributed to polyneuritis (peripheral anesthesia, acroparaethesia, pain in the extremities, hyperreflexia of the tendon, numbness, convulsions, paralysis, motor disturbances, and hemiplegia).

In humans, inhalation of selenium or selenium compounds primarily affects the respiratory system. Dusts of elemental selenium and selenium dioxide can cause irritation of the skin and mucous membranes of the nose and throat, coughing, nosebleed, loss of sense of smell, dyspnea, bronchial spasms, bronchitis, and chemical pneumonia (Clinton, 1947; Hamilton, 1949). Other signs and symptoms following acute inhalation exposures include lacrimation, irritation and redness of the eyes, gastrointestinal distress

(nausea and vomiting), depressed blood pressure, elevated pulse rate, headaches, dizziness, and malaise (ATSDR, 1989). Information on toxicity of selenium in humans following chronic inhalation exposures is not available.

Some epidemiologic studies have indicated that selenium may have anti-neoplastic properties (see Whanger, 1983; Hocman, 1988). In studies on laboratory animals, selenites or selenates have not been found to be carcinogenic; however, selenium sulfide produced a significant increase in the incidence of hepatocellular carcinomas in male and female rats and in female mice and a significant increase in alveolar/bronchiolar carcinomas and adenomas in female mice following chronic oral exposures (NCI, 1980c). EPA has placed selenium and selenious acid in Group D, not classifiable as to carcinogenicity in humans (U.S. EPA, 1992a and 1992b), while selenium sulfide is placed in Group B2, probable human carcinogen (U.S. EPA, 1992d). Quantitative data are, however, insufficient to derive a slope factor for selenium sulfide. Pertinent data regarding the potential carcinogenicity of selenium by the inhalation route in humans or animals were not located in the available literature.

Environmental Toxicity

In domesticated animals, subchronic and chronic oral exposures can result in loss of hair, malformed hooves, rough hair coat, and nervous system abnormalities (impaired vision and paralysis). Damage to the liver and kidneys and impaired immune responses have been reported to occur in rodents following subchronic and/or chronic oral exposures (Ganther and Baumann, 1962; Beems and van Beek, 1985; NCI, 1980a; Tinsley et al., 1967; Harr et al., 1967; Schroeder, 1967).

Selenium is teratogenic in birds and possibly also in domesticated animals (pigs, sheep, and cattle), but evidence of teratogenicity in humans and laboratory animals is lacking (ASTDR, 1989). However, adverse reproductive and developmental effects (decreased rates of conception, increased rates of fetal resorption, and reduced fetal body weights) have been reported for domesticated and laboratory animals (Harr and Muth, 1972: Wahlstrom and Olson, 1959; Schroeder and Mitchener, 1971b).

In animals, acute inhalation exposures result in severe respiratory effects including edema, hemorrhage, and interstitial pneumonitis (Hall et al., 1951; Dudley and Miller, 1937) as well as in splenic damage (congestion, fissuring red pulp, and increased polymorphonuclear leukocytes) and liver congestion and mild central atrophy (Hall et al., 1951). Information on toxicity of selenium in animals following chronic inhalation exposures is not available.

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Appendix B
Human Health Risk Characterization Calculations

APPENDIX B
TABLE B-1
RISK CHARACTERIZATION SUMMARY
TRESPASSERS
Former McCoy Field Wetland Area
New Bedford, Massachusetts

Exposure Pathway	Child Exposure		Youth Exposure		Adult Exposure		Combined Ages
	Non-Carcinogenic Hazard Index	Excess Lifetime Cancer Risk	Non-Carcinogenic Hazard Index	Excess Lifetime Cancer Risk	Non-Carcinogenic Hazard Index	Excess Lifetime Cancer Risk	Excess Lifetime Cancer Risk
Soil/Sediment Ingestion	0.2	5E-07	0.05	1E-07	0.03	2E-07	8E-07
Soil/Sediment Dermal Contact	0.08	3E-07	0.02	8E-08	0.01	9E-08	5E-07
Inhalation of Entrained Soil/Sediment Particles	0.0006	4E-10	0.0006	4E-10	0.0006	1E-09	2E-09
Surface Water Ingestion	0.0005	4E-10	0.0002	2E-10	0.0001	3E-10	9E-10
Surface Water Dermal Contact	0.0001	1E-08	0.00009	1E-08	0.00006	2E-08	5E-08
Total (All Pathways)	**0.3**	**9E-07**	**0.07**	**2E-07**	**0.04**	**3E-07**	**1E-06**
MADEP Maximum Acceptable Level	**1.0**	**1E-05**	**1.0**	**1E-05**	**1.0**	**1E-05**	**1E-05**

APPENDIX B
TABLE B-2
RISK CHARACTERIZATION
SOIL INGESTION
TRESPASSERS
Former McCoy Field Wetland Area
New Bedford, Massachusetts

Equation: **ADD =** $\frac{C_{soil}\ IR_{soil}\ RAFo\ EF\ ED\ EP\ CF}{BW\ AP}$

HQ = ADD/RfD
HI = Sum [HQ]
Risk = ADD x SF

where:
- ADD = Average daily dose (mg/kg-dy)
- C_{soil} = Constituent concentration in soil (mg/kg)
- IR_{soil} = Soil ingestion rate (kg/dy)
- RAFo = Oral relative absorption factor (unitless)
- EF = Exposure frequency (events/year)
- ED = Exposure duration (day/event)
- EP = Exposure period (yr)
- CF = Unit conversion factor (yr/dy)
- BW = Body weight (kg)
- AP = Averaging period (yr) (nc = non-carcinogen; ca = carcinogen)

where:
- HQ = Non-carcinogenic hazard quotient (unitless)
- HI = Total hazard index (unitless)
- Risk = Excess lifetime cancer risk (unitless)
- RfD= Reference dose (mg/kg-dy)
- SF = Cancer slope factor [$(mg/kg\text{-}dy)^{-1}$]

Child Exposure (ages 1 to 8)

Constituent	C_{soil} (mg/kg)	IR_{soil} (kg/dy)	RAFo (unitless)	EF (events/yr)	ED (dy/event)	EP (yr)	CF (yr/dy)	BW (kg)	AP (nc) (yr)	ADD (nc) (mg/kg-dy)	RfD (mg/kg-dy)	HQ (unitless)	AP [ca] (yr)	ADD [ca] (mg/kg-dy)	SF [(mg/kg-dy)$^{-1}$]	Risk (unitless)
Acenaphthene	0.191	0.0001	1	80	1	7	2.74E-03	17	7	2.46E-07	0.06	0.000004	--	--	--	--
Anthracene	0.203	0.0001	1	80	1	7	2.74E-03	17	7	2.62E-07	0.3	0.0000009	--	--	--	--
Benzo(a)anthracene	0.255	0.0001	1	80	1	7	2.74E-03	17	7	3.29E-07	0.03	0.00001	70	3.29E-08	0.73	2E-08
Benzo(b)fluoranthene	0.274	0.0001	1	80	1	7	2.74E-03	17	7	3.53E-07	0.03	0.00001	70	3.53E-08	0.73	3E-08
Benzo(k)fluoranthene	0.218	0.0001	1	80	1	7	2.74E-03	17	7	2.81E-07	0.03	0.000009	70	2.81E-08	0.073	2E-09
Benzo(g,h,i)perylene	0.213	0.0001	1	80	1	7	2.74E-03	17	7	2.75E-07	0.03	0.000009	--	--	--	--
Benzo(a)pyrene	0.249	0.0001	1	80	1	7	2.74E-03	17	7	3.21E-07	0.03	0.00001	70	3.21E-08	7.3	2E-07
Chrysene	0.246	0.0001	1	80	1	7	2.74E-03	17	7	3.17E-07	0.03	0.00001	70	3.17E-08	0.073	2E-09
Fluoranthene	0.329	0.0001	1	80	1	7	2.74E-03	17	7	4.24E-07	0.04	0.00001	--	--	--	--
Fluorene	0.191	0.0001	1	80	1	7	2.74E-03	17	7	2.46E-07	0.04	0.000006	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.208	0.0001	1	80	1	7	2.74E-03	17	7	2.68E-07	0.03	0.000009	70	2.68E-08	0.73	2E-08
Phenanthrene	0.274	0.0001	1	80	1	7	2.74E-03	17	7	3.53E-07	0.03	0.00001	--	--	--	--
Pyrene	0.351	0.0001	1	80	1	7	2.74E-03	17	7	4.53E-07	0.03	0.00002	--	--	--	--
Barium	83	0.0001	1	80	1	7	2.74E-03	17	7	1.07E-04	0.07	0.002	--	--	--	--
Cadmium	1.05	0.0001	1	80	1	7	2.74E-03	17	7	1.35E-06	0.001	0.001	--	--	--	--
Chromium (total)	13	0.0001	1	80	1	7	2.74E-03	17	7	1.68E-05	1.5	0.00001	--	--	--	--
Lead	98	0.0001	1	80	1	7	2.74E-03	17	7	1.26E-04	0.00075	0.2	--	--	--	--
Mercury	0.15	0.0001	1	80	1	7	2.74E-03	17	7	1.93E-07	0.0003	0.0006	--	--	--	--
Selenium	0.92	0.0001	1	80	1	7	2.74E-03	17	7	1.19E-06	0.005	0.0002	--	--	--	--
PCB (Aroclor 1254)	0.908	0.0001	1	80	1	7	2.74E-03	17	7	1.17E-06	0.00002	0.06	70	1.17E-07	2	2E-07
Total									**HI =**			**0.2**	**Risk =**			**5E-07**

APPENDIX B
TABLE B-2
RISK CHARACTERIZATION
SOIL INGESTION
TRESPASSERS
Former McCoy Field Wetland Area
New Bedford, Massachusetts

Youth Exposure (ages 8 to 15)

Constituent	C_{soil} (mg/kg)	IR_{soil} (kg/dy)	RAFo (unitless)	EF (events/yr)	ED (dy/event)	EP (yr)	CF (yr/dy)	BW (kg)	AP (nc) (yr)	ADD (nc) (mg/kg-dy)	RfD (mg/kg-dy)	HQ (unitless)	AP [ca] (yr)	ADD [ca] (mg/kg-dy)	SF [(mg/kg-dy)$^{-1}$]	Risk (unitless)
Acenaphthene	0.191	0.00005	1	80	1	7	2.74E-03	39.9	7	5.25E-08	0.06	0.0000009	--	--	--	--
Anthracene	0.203	0.00005	1	80	1	7	2.74E-03	39.9	7	5.58E-08	0.3	0.0000002	--	--	--	--
Benzo(a)anthracene	0.255	0.00005	1	80	1	7	2.74E-03	39.9	7	7.00E-08	0.03	0.000002	70	7.00E-09	0.73	5E-09
Benzo(b)fluoranthene	0.274	0.00005	1	80	1	7	2.74E-03	39.9	7	7.53E-08	0.03	0.000003	70	7.53E-09	0.73	5E-09
Benzo(k)fluoranthene	0.218	0.00005	1	80	1	7	2.74E-03	39.9	7	5.99E-08	0.03	0.000002	70	5.99E-09	0.073	4E-10
Benzo(g,h,i)perylene	0.213	0.00005	1	80	1	7	2.74E-03	39.9	7	5.85E-08	0.03	0.000002	--	--	--	--
Benzo(a)pyrene	0.249	0.00005	1	80	1	7	2.74E-03	39.9	7	6.84E-08	0.03	0.000002	70	6.84E-09	7.3	5E-08
Chrysene	0.246	0.00005	1	80	1	7	2.74E-03	39.9	7	6.76E-08	0.03	0.000002	70	6.76E-09	0.073	5E-10
Fluoranthene	0.329	0.00005	1	80	1	7	2.74E-03	39.9	7	9.04E-08	0.04	0.000002	--	--	--	--
Fluorene	0.191	0.00005	1	80	1	7	2.74E-03	39.9	7	5.25E-08	0.04	0.000001	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.208	0.00005	1	80	1	7	2.74E-03	39.9	7	5.71E-08	0.03	0.000002	70	5.71E-09	0.73	4E-09
Phenanthrene	0.274	0.00005	1	80	1	7	2.74E-03	39.9	7	7.53E-08	0.03	0.000003	--	--	--	--
Pyrene	0.351	0.00005	1	80	1	7	2.74E-03	39.9	7	9.64E-08	0.03	0.000003	--	--	--	--
Barium	83	0.00005	1	80	1	7	2.74E-03	39.9	7	2.28E-05	0.07	0.0003	--	--	--	--
Cadmium	1.05	0.00005	1	80	1	7	2.74E-03	39.9	7	2.88E-07	0.001	0.0003	--	--	--	--
Chromium (total)	13	0.00005	1	80	1	7	2.74E-03	39.9	7	3.57E-06	1.5	0.000002	--	--	--	--
Lead	98	0.00005	1	80	1	7	2.74E-03	39.9	7	2.69E-05	0.00075	0.04	--	--	--	--
Mercury	0.15	0.00005	1	80	1	7	2.74E-03	39.9	7	4.12E-08	0.0003	0.0001	--	--	--	--
Selenium	0.92	0.00005	1	80	1	7	2.74E-03	39.9	7	2.53E-07	0.005	0.00005	--	--	--	--
PCB (Aroclor 1254)	0.908	0.00005	1	80	1	7	2.74E-03	39.9	7	2.49E-07	0.00002	0.01	70	2.49E-08	2	5E-08
Total									**HI =**			**0.05**	**Risk =**			**1E-07**

Adult Exposure (ages 15 to 31)

Constituent	C_{soil} (mg/kg)	IR_{soil} (kg/dy)	RAFo (unitless)	EF (events/yr)	ED (dy/event)	EP (yr)	CF (yr/dy)	BW (kg)	AP (nc) (yr)	ADD (nc) (mg/kg-dy)	RfD (mg/kg-dy)	HQ (unitless)	AP [ca] (yr)	ADD [ca] (mg/kg-dy)	SF [(mg/kg-dy)$^{-1}$]	Risk (unitless)
Acenaphthene	0.191	0.00005	1	80	1	16	2.74E-03	58.7	16	3.57E-08	0.06	0.0000006	--	--	--	--
Anthracene	0.203	0.00005	1	80	1	16	2.74E-03	58.7	16	3.79E-08	0.3	0.0000001	--	--	--	--
Benzo(a)anthracene	0.255	0.00005	1	80	1	16	2.74E-03	58.7	16	4.76E-08	0.03	0.000002	70	1.09E-08	0.73	8E-09
Benzo(b)fluoranthene	0.274	0.00005	1	80	1	16	2.74E-03	58.7	16	5.12E-08	0.03	0.000002	70	1.17E-08	0.73	9E-09
Benzo(k)fluoranthene	0.218	0.00005	1	80	1	16	2.74E-03	58.7	16	4.07E-08	0.03	0.000001	70	9.30E-09	0.073	7E-10
Benzo(g,h,i)perylene	0.213	0.00005	1	80	1	16	2.74E-03	58.7	16	3.98E-08	0.03	0.000001	--	--	--	--
Benzo(a)pyrene	0.249	0.00005	1	80	1	16	2.74E-03	58.7	16	4.65E-08	0.03	0.000002	70	1.06E-08	7.3	8E-08
Chrysene	0.246	0.00005	1	80	1	16	2.74E-03	58.7	16	4.59E-08	0.03	0.000002	70	1.05E-08	0.073	8E-10
Fluoranthene	0.329	0.00005	1	80	1	16	2.74E-03	58.7	16	6.14E-08	0.04	0.000002	--	--	--	--
Fluorene	0.191	0.00005	1	80	1	16	2.74E-03	58.7	16	3.57E-08	0.04	0.0000009	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.208	0.00005	1	80	1	16	2.74E-03	58.7	16	3.88E-08	0.03	0.000001	70	8.88E-09	0.73	6E-09
Phenanthrene	0.274	0.00005	1	80	1	16	2.74E-03	58.7	16	5.12E-08	0.03	0.000002	--	--	--	--
Pyrene	0.351	0.00005	1	80	1	16	2.74E-03	58.7	16	6.55E-08	0.03	0.000002	--	--	--	--
Barium	83	0.00005	1	80	1	16	2.74E-03	58.7	16	1.55E-05	0.07	0.0002	--	--	--	--
Cadmium	1.05	0.00005	1	80	1	16	2.74E-03	58.7	16	1.96E-07	0.001	0.0002	--	--	--	--
Chromium (total)	13	0.00005	1	80	1	16	2.74E-03	58.7	16	2.43E-06	1.5	0.000002	--	--	--	--
Lead	98	0.00005	1	80	1	16	2.74E-03	58.7	16	1.83E-05	0.00075	0.02	--	--	--	--
Mercury	0.15	0.00005	1	80	1	16	2.74E-03	58.7	16	2.80E-08	0.0003	0.00009	--	--	--	--
Selenium	0.92	0.00005	1	80	1	16	2.74E-03	58.7	16	1.72E-07	0.005	0.00003	--	--	--	--
PCB (Aroclor 1254)	0.908	0.00005	1	80	1	16	2.74E-03	58.7	16	1.70E-07	0.00002	0.008	70	3.87E-08	2	8E-08
Total									**HI =**			**0.03**	**Risk =**			**2E-07**

Combined ages (1 to 31)

Total Risk	**8E-07**

APPENDIX B
TABLE B-3
RISK CHARACTERIZATION
SOIL DERMAL CONTACT
TRESPASSERS
Former McCoy Field Wetland Area
New Bedford, Massachusetts

Equation: $$ADD = \frac{C_{soil}\ SA\ AF\ RAFd\ EF\ ED\ EP\ CF}{BW\ AP}$$

HQ = ADD / RfD
HI = Sum [HQ]
Risk = ADD x SF

where:
- ADD = Average daily dose (mg/kg-dy)
- C_{soil} = Constituent concentration in soil (mg/kg)
- SA = Exposed skin surface area (cm^2/dy)
- AF = Soil adherence factor (kg/cm^2)
- RAFd = Dermal relative absorption factor (unitless)
- EF = Exposure frequency (events/yr)
- ED = Exposure duration (day/event)
- EP = Exposure period (yr)
- CF = Unit conversion factor (yr/dy)
- BW = Body weight (kg)
- AP = Averaging period (yr) (nc = non-carcinogen; ca = carcinogen)

where:
- HQ = Non-carcinogenic hazard quotient (unitless)
- HI = Total hazard index (unitless)
- Risk = Excess lifetime cancer risk (unitless)
- RfD= Reference dose (mg/kg-dy)
- SF = Cancer slope factor [$(mg/kg\text{-}dy)^{-1}$]

Child Exposure (ages 1 to 8)

Constituent	C_{soil} (mg/kg)	SA (cm^2/dy)	AF (kg/cm^2)	RAFd (unitless)	EF (events/yr)	ED (dy/event)	EP (yr)	CF (yr/dy)	BW (kg)	AP (nc) (yr)	ADD (nc) (mg/kg-dy)	RfD (mg/kg-dy)	HQ (unitless)	AP [ca] (yr)	ADD [ca] (mg/kg-dy)	SF [(mg/kg-dy)$^{-1}$]	Risk (unitless)
Acenaphthene	0.191	1,351	5.2E-07	0.1	80	1	7	2.74E-03	17	7	1.73E-07	0.06	0.000003	--	--	--	--
Anthracene	0.203	1,351	5.2E-07	0.1	80	1	7	2.74E-03	17	7	1.84E-07	0.3	0.0000006	--	--	--	--
Benzo(a)anthracene	0.255	1,351	5.2E-07	0.02	80	1	7	2.74E-03	17	7	4.62E-08	0.03	0.000002	70	4.62E-09	0.73	3E-09
Benzo(b)fluoranthene	0.274	1,351	5.2E-07	0.02	80	1	7	2.74E-03	17	7	4.96E-08	0.03	0.000002	70	4.96E-09	0.73	4E-09
Benzo(k)fluoranthene	0.218	1,351	5.2E-07	0.02	80	1	7	2.74E-03	17	7	3.95E-08	0.03	0.000001	70	3.95E-09	0.073	3E-10
Benzo(g,h,i)perylene	0.213	1,351	5.2E-07	0.1	80	1	7	2.74E-03	17	7	1.93E-07	0.03	0.000006	--	--	--	--
Benzo(a)pyrene	0.249	1,351	5.2E-07	0.02	80	1	7	2.74E-03	17	7	4.51E-08	0.03	0.000002	70	4.51E-09	7.3	3E-08
Chrysene	0.246	1,351	5.2E-07	0.02	80	1	7	2.74E-03	17	7	4.46E-08	0.03	0.000001	70	4.46E-09	0.073	3E-10
Fluoranthene	0.329	1,351	5.2E-07	0.1	80	1	7	2.74E-03	17	7	2.98E-07	0.04	0.000007	--	--	--	--
Fluorene	0.191	1,351	5.2E-07	0.1	80	1	7	2.74E-03	17	7	1.73E-07	0.04	0.000004	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.208	1,351	5.2E-07	0.02	80	1	7	2.74E-03	17	7	3.77E-08	0.03	0.000001	70	3.77E-09	0.73	3E-09
Phenanthrene	0.274	1,351	5.2E-07	0.1	80	1	7	2.74E-03	17	7	2.48E-07	0.03	0.000008	--	--	--	--
Pyrene	0.351	1,351	5.2E-07	0.1	80	1	7	2.74E-03	17	7	3.18E-07	0.03	0.00001	--	--	--	--
Barium	83	1,351	5.2E-07	0.05	80	1	7	2.74E-03	17	7	3.76E-05	0.07	0.0005	--	--	--	--
Cadmium	1.05	1,351	5.2E-07	0.14	80	1	7	2.74E-03	17	7	1.33E-06	0.001	0.001	--	--	--	--
Chromium (total)	13	1,351	5.2E-07	0.04	80	1	7	2.74E-03	17	7	4.71E-06	1.5	0.000003	--	--	--	--
Lead	98	1,351	5.2E-07	0.006	80	1	7	2.74E-03	17	7	5.33E-06	0.00075	0.007	--	--	--	--
Mercury	0.15	1,351	5.2E-07	0.05	80	1	7	2.74E-03	17	7	6.79E-08	0.0003	0.0002	--	--	--	--
Selenium	0.92	1,351	5.2E-07	0.002	80	1	7	2.74E-03	17	7	1.67E-08	0.005	0.000003	--	--	--	--
PCB (Aroclor 1254)	0.908	1,351	5.2E-07	0.16	80	1	7	2.74E-03	17	7	1.32E-06	0.00002	0.07	70	1.32E-07	2	3E-07
Total										**HI =**			**0.08**	**Risk =**			**3E-07**

APPENDIX B
TABLE B-3
RISK CHARACTERIZATION
SOIL DERMAL CONTACT
TRESPASSERS
Former McCoy Field Wetland Area
New Bedford, Massachusetts

Youth Exposure (ages 8 to 15)

Constituent	C_{soil} (mg/kg)	SA (cm^2/dy)	AF (kg/cm^2)	RAFd (unitless)	EF (events/yr)	ED (dy/event)	EP (yr)	CF (yr/dy)	BW (kg)	AP (nc) (yr)	ADD (nc) (mg/kg-dy)	RfD (mg/kg-dy)	HQ (unitless)	AP [ca] (yr)	ADD [ca] (mg/kg-dy)	SF [(mg/kg-dy)$^{-1}$]	Risk (unitless)
Acenaphthene	0.191	2,928	1.4E-07	0.1	80	1	7	2.74E-03	39.9	7	4.30E-08	0.06	0.0000007	--	--	--	--
Anthracene	0.203	2,928	1.4E-07	0.1	80	1	7	2.74E-03	39.9	7	4.57E-08	0.3	0.0000002	--	--	--	--
Benzo(a)anthracene	0.255	2,928	1.4E-07	0.02	80	1	7	2.74E-03	39.9	7	1.15E-08	0.03	0.0000004	70	1.15E-09	0.73	8E-10
Benzo(b)fluoranthene	0.274	2,928	1.4E-07	0.02	80	1	7	2.74E-03	39.9	7	1.23E-08	0.03	0.0000004	70	1.23E-09	0.73	9E-10
Benzo(k)fluoranthene	0.218	2,928	1.4E-07	0.02	80	1	7	2.74E-03	39.9	7	9.82E-09	0.03	0.0000003	70	9.82E-10	0.073	7E-11
Benzo(g,h,i)perylene	0.213	2,928	1.4E-07	0.1	80	1	7	2.74E-03	39.9	7	4.80E-08	0.03	0.000002	--	--	--	--
Benzo(a)pyrene	0.249	2,928	1.4E-07	0.02	80	1	7	2.74E-03	39.9	7	1.12E-08	0.03	0.0000004	70	1.12E-09	7.3	8E-09
Chrysene	0.246	2,928	1.4E-07	0.02	80	1	7	2.74E-03	39.9	7	1.11E-08	0.03	0.0000004	70	1.11E-09	0.073	8E-11
Fluoranthene	0.329	2,928	1.4E-07	0.1	80	1	7	2.74E-03	39.9	7	7.41E-08	0.04	0.000002	--	--	--	--
Fluorene	0.191	2,928	1.4E-07	0.1	80	1	7	2.74E-03	39.9	7	4.30E-08	0.04	0.000001	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.208	2,928	1.4E-07	0.02	80	1	7	2.74E-03	39.9	7	9.37E-09	0.03	0.0000003	70	9.37E-10	0.73	7E-10
Phenanthrene	0.274	2,928	1.4E-07	0.1	80	1	7	2.74E-03	39.9	7	6.17E-08	0.03	0.000002	--	--	--	--
Pyrene	0.351	2,928	1.4E-07	0.1	80	1	7	2.74E-03	39.9	7	7.90E-08	0.03	0.000003	--	--	--	--
Barium	83	2,928	1.4E-07	0.05	80	1	7	2.74E-03	39.9	7	9.34E-06	0.07	0.0001	--	--	--	--
Cadmium	1.05	2,928	1.4E-07	0.14	80	1	7	2.74E-03	39.9	7	3.31E-07	0.001	0.0003	--	--	--	--
Chromium (total)	13	2,928	1.4E-07	0.04	80	1	7	2.74E-03	39.9	7	1.17E-06	1.5	0.0000008	--	--	--	--
Lead	98	2,928	1.4E-07	0.006	80	1	7	2.74E-03	39.9	7	1.32E-06	0.00075	0.002	--	--	--	--
Mercury	0.15	2,928	1.4E-07	0.05	80	1	7	2.74E-03	39.9	7	1.69E-08	0.0003	0.00006	--	--	--	--
Selenium	0.92	2,928	1.4E-07	0.002	80	1	7	2.74E-03	39.9	7	4.14E-09	0.005	0.0000008	--	--	--	--
PCB (Aroclor 1254)	0.908	2,928	1.4E-07	0.16	80	1	7	2.74E-03	39.9	7	3.27E-07	0.00002	0.02	70	3.27E-08	2	7E-08
Total										**HI =**			**0.02**	**Risk =**			**8E-08**

Adult Exposure (ages 15 to 31)

Constituent	C_{soil} (mg/kg)	SA (cm^2/dy)	AF (kg/cm^2)	RAFd (unitless)	EF (events/yr)	ED (dy/event)	EP (yr)	CF (yr/dy)	BW (kg)	AP (nc) (yr)	ADD (nc) (mg/kg-dy)	RfD (mg/kg-dy)	HQ (unitless)	AP [ca] (yr)	ADD [ca] (mg/kg-dy)	SF [(mg/kg-dy)$^{-1}$]	Risk (unitless)
Acenaphthene	0.191	3,107	1.0E-07	0.1	80	1	16	2.74E-03	58.7	16	2.22E-08	0.06	0.0000004	--	--	--	--
Anthracene	0.203	3,107	1.0E-07	0.1	80	1	16	2.74E-03	58.7	16	2.36E-08	0.3	0.00000008	--	--	--	--
Benzo(a)anthracene	0.255	3,107	1.0E-07	0.02	80	1	16	2.74E-03	58.7	16	5.92E-09	0.03	0.0000002	70	1.35E-09	0.73	1E-09
Benzo(b)fluoranthene	0.274	3,107	1.0E-07	0.02	80	1	16	2.74E-03	58.7	16	6.36E-09	0.03	0.0000002	70	1.45E-09	0.73	1E-09
Benzo(k)fluoranthene	0.218	3,107	1.0E-07	0.02	80	1	16	2.74E-03	58.7	16	5.06E-09	0.03	0.0000002	70	1.16E-09	0.073	8E-11
Benzo(g,h,i)perylene	0.213	3,107	1.0E-07	0.1	80	1	16	2.74E-03	58.7	16	2.47E-08	0.03	0.0000008	--	--	--	--
Benzo(a)pyrene	0.249	3,107	1.0E-07	0.02	80	1	16	2.74E-03	58.7	16	5.78E-09	0.03	0.0000002	70	1.32E-09	7.3	1E-08
Chrysene	0.246	3,107	1.0E-07	0.02	80	1	16	2.74E-03	58.7	16	5.71E-09	0.03	0.0000002	70	1.30E-09	0.073	1E-10
Fluoranthene	0.329	3,107	1.0E-07	0.1	80	1	16	2.74E-03	58.7	16	3.82E-08	0.04	0.000001	--	--	--	--
Fluorene	0.191	3,107	1.0E-07	0.1	80	1	16	2.74E-03	58.7	16	2.22E-08	0.04	0.0000006	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.208	3,107	1.0E-07	0.02	80	1	16	2.74E-03	58.7	16	4.83E-09	0.03	0.0000002	70	1.10E-09	0.73	8E-10
Phenanthrene	0.274	3,107	1.0E-07	0.1	80	1	16	2.74E-03	58.7	16	3.18E-08	0.03	0.000001	--	--	--	--
Pyrene	0.351	3,107	1.0E-07	0.1	80	1	16	2.74E-03	58.7	16	4.07E-08	0.03	0.000001	--	--	--	--
Barium	83	3,107	1.0E-07	0.05	80	1	16	2.74E-03	58.7	16	4.81E-06	0.07	0.00007	--	--	--	--
Cadmium	1.05	3,107	1.0E-07	0.14	80	1	16	2.74E-03	58.7	16	1.71E-07	0.001	0.0002	--	--	--	--
Chromium (total)	13	3,107	1.0E-07	0.04	80	1	16	2.74E-03	58.7	16	6.03E-07	1.5	0.0000004	--	--	--	--
Lead	98	3,107	1.0E-07	0.006	80	1	16	2.74E-03	58.7	16	6.82E-07	0.00075	0.0009	--	--	--	--
Mercury	0.15	3,107	1.0E-07	0.05	80	1	16	2.74E-03	58.7	16	8.70E-09	0.0003	0.00003	--	--	--	--
Selenium	0.92	3,107	1.0E-07	0.002	80	1	16	2.74E-03	58.7	16	2.13E-09	0.005	0.0000004	--	--	--	--
PCB (Aroclor 1254)	0.908	3,107	1.0E-07	0.16	80	1	16	2.74E-03	58.7	16	1.69E-07	0.00002	0.008	70	3.85E-08	2	8E-08
Total										**HI =**			**0.01**	**Risk =**			**9E-08**

Combined ages (1 to 31)

Total Risk	**5E-07**

APPENDIX B
TABLE B-4
RISK CHARACTERIZATION
INHALATION OF ENTRAINED SOIL PARTICLES
TRESPASSERS
Former McCoy Field Wetland Area
New Bedford, Massachusetts

$C_{air} = C_{soil} \times PM_{10} \times CF$

$ADE = C_{air} \times EF \times ED \times EP \times CF / AP$

$HQ = ADE / RfC$

$HI = Sum\ [HQ]$

$Risk = ADE \times UR$

where:

C_{air} = Constituent concentration in ambient air (mg/m^3)
C_{soil} = Constituent concentration in soil (mg/kg)
PM_{10} = Particulate matter concentration in air (</= 10 microns) (mg/m^3)
CF = Unit conversion factor (kg/mg)
ADE = Average daily exposure (mg/m^3)
EF = Exposure frequency (events/yr)
ED = Exposure duration (hr/event)
EP = Exposure period (yr)
CF = Unit conversion factor (yr/hr)
AP = Averaging period (yr) (nc = non-carcinogen; ca = carcinogen)

where:

HQ = Non-carcinogenic hazard quotient (unitless)
HI = Total hazard index (unitless)
RfC= Reference concentration (mg/m^3)
Risk = Excess lifetime cancer risk (unitless)
UR = Unit risk value [$(mg/m^3)^{-1}$]

Child Exposure (ages 1 to 8)

Constituent	C_{soil} (mg/kg)	PM_{10} (mg/m^3)	CF (kg/mg)	C_{air} (mg/m^3)	EF (events/yr)	ED (hr/event)	EP (yr)	CF (yr/hr)	AP (nc) (yr)	ADE (nc) (mg/m^3)	RfC (mg/m^3)	HQ (unitless)	AP [ca] (yr)	ADE [ca] (mg/m^3)	UR $[(mg/m^3)^{-1}]$	Risk (unitless)
Acenaphthene	0.191	0.032	1.00E-06	6.11E-09	80	5.6	7	1.14E-04	7	3.13E-10	0.05	0.000000006	--	--	--	--
Anthracene	0.203	0.032	1.00E-06	6.50E-09	80	5.6	7	1.14E-04	7	3.32E-10	0.05	0.000000007	--	--	--	--
Benzo(a)anthracene	0.255	0.032	1.00E-06	8.16E-09	80	5.6	7	1.14E-04	7	4.17E-10	0.05	0.000000008	70	4.17E-11	0.21	9E-12
Benzo(b)fluoranthene	0.274	0.032	1.00E-06	8.77E-09	80	5.6	7	1.14E-04	7	4.48E-10	0.05	0.000000009	70	4.48E-11	0.21	9E-12
Benzo(k)fluoranthene	0.218	0.032	1.00E-06	6.98E-09	80	5.6	7	1.14E-04	7	3.57E-10	0.05	0.000000007	70	3.57E-11	0.021	7E-13
Benzo(g,h,i)perylene	0.213	0.032	1.00E-06	6.82E-09	80	5.6	7	1.14E-04	7	3.49E-10	0.05	0.000000007	--	--	--	--
Benzo(a)pyrene	0.249	0.032	1.00E-06	7.97E-09	80	5.6	7	1.14E-04	7	4.07E-10	0.05	0.000000008	70	4.07E-11	2.1	9E-11
Chrysene	0.246	0.032	1.00E-06	7.87E-09	80	5.6	7	1.14E-04	7	4.03E-10	0.05	0.000000008	70	4.03E-11	0.021	8E-13
Fluoranthene	0.329	0.032	1.00E-06	1.05E-08	80	5.6	7	1.14E-04	7	5.38E-10	0.05	0.00000001	--	--	--	--
Fluorene	0.191	0.032	1.00E-06	6.11E-09	80	5.6	7	1.14E-04	7	3.13E-10	0.05	0.000000006	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.208	0.032	1.00E-06	6.66E-09	80	5.6	7	1.14E-04	7	3.40E-10	0.05	0.000000007	70	3.40E-11	0.21	7E-12
Phenanthrene	0.274	0.032	1.00E-06	8.77E-09	80	5.6	7	1.14E-04	7	4.48E-10	0.05	0.000000009	--	--	--	--
Pyrene	0.351	0.032	1.00E-06	1.12E-08	80	5.6	7	1.14E-04	7	5.74E-10	0.05	0.00000001	--	--	--	--
Barium	83	0.032	1.00E-06	2.66E-06	80	5.6	7	1.14E-04	7	1.36E-07	0.0005	0.0003	--	--	--	--
Cadmium	1.05	0.032	1.00E-06	3.36E-08	80	5.6	7	1.14E-04	7	1.72E-09	0.00002	0.00009	70	1.72E-10	1.8	3E-10
Chromium (total)	13	0.032	1.00E-06	4.16E-07	80	5.6	7	1.14E-04	7	2.13E-08	5	0.000000004	--	--	--	--
Lead	98	0.032	1.00E-06	3.14E-06	80	5.6	7	1.14E-04	7	1.60E-07	0.001	0.0002	--	--	--	--
Mercury	0.15	0.032	1.00E-06	4.80E-09	80	5.6	7	1.14E-04	7	2.45E-10	0.0003	0.0000008	--	--	--	--
Selenium	0.92	0.032	1.00E-06	2.94E-08	80	5.6	7	1.14E-04	7	1.51E-09	0.003	0.0000005	--	--	--	--
PCB (Aroclor 1254)	0.908	0.032	1.00E-06	2.91E-08	80	5.6	7	1.14E-04	7	1.49E-09	0.00002	0.00007	70	1.49E-10	0.1	1E-11
Total									HI =			0.0006	Risk =			4E-10

APPENDIX B
TABLE B-4
RISK CHARACTERIZATION
INHALATION OF ENTRAINED SOIL PARTICLES
TRESPASSERS
Former McCoy Field Wetland Area
New Bedford, Massachusetts

Youth Exposure (ages 8 to 15)

Constituent	C_{soil} (mg/kg)	PM_{10} (mg/m^3)	CF (kg/mg)	C_{air} (mg/m^3)	EF (events/yr)	ED (hr/event)	EP (yr)	CF (yr/hr)	AP (nc) (yr)	ADE (nc) (mg/m^3)	RfC (mg/m^3)	HQ (unitless)	AP [ca] (yr)	ADE [ca] (mg/m^3)	UR $[(mg/m^3)^{-1}]$	Risk (unitless)
Acenaphthene	0.191	0.032	1.00E-06	6.11E-09	80	5.6	7	1.14E-04	7	3.13E-10	0.05	0.000000006	--	--	--	--
Anthracene	0.203	0.032	1.00E-06	6.50E-09	80	5.6	7	1.14E-04	7	3.32E-10	0.05	0.000000007	--	--	--	--
Benzo(a)anthracene	0.255	0.032	1.00E-06	8.16E-09	80	5.6	7	1.14E-04	7	4.17E-10	0.05	0.000000008	70	4.17E-11	0.21	9E-12
Benzo(b)fluoranthene	0.274	0.032	1.00E-06	8.77E-09	80	5.6	7	1.14E-04	7	4.48E-10	0.05	0.000000009	70	4.48E-11	0.21	9E-12
Benzo(k)fluoranthene	0.218	0.032	1.00E-06	6.98E-09	80	5.6	7	1.14E-04	7	3.57E-10	0.05	0.000000007	70	3.57E-11	0.021	7E-13
Benzo(g,h,i)perylene	0.213	0.032	1.00E-06	6.82E-09	80	5.6	7	1.14E-04	7	3.49E-10	0.05	0.000000007	--	--	--	--
Benzo(a)pyrene	0.249	0.032	1.00E-06	7.97E-09	80	5.6	7	1.14E-04	7	4.07E-10	0.05	0.000000008	70	4.07E-11	2.1	9E-11
Chrysene	0.246	0.032	1.00E-06	7.87E-09	80	5.6	7	1.14E-04	7	4.03E-10	0.05	0.000000008	70	4.03E-11	0.021	8E-13
Fluoranthene	0.329	0.032	1.00E-06	1.05E-08	80	5.6	7	1.14E-04	7	5.38E-10	0.05	0.00000001	--	--	--	--
Fluorene	0.191	0.032	1.00E-06	6.11E-09	80	5.6	7	1.14E-04	7	3.13E-10	0.05	0.000000006	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.208	0.032	1.00E-06	6.66E-09	80	5.6	7	1.14E-04	7	3.40E-10	0.05	0.000000007	70	3.40E-11	0.21	7E-12
Phenanthrene	0.274	0.032	1.00E-06	8.77E-09	80	5.6	7	1.14E-04	7	4.48E-10	0.05	0.000000009	--	--	--	--
Pyrene	0.351	0.032	1.00E-06	1.12E-08	80	5.6	7	1.14E-04	7	5.74E-10	0.05	0.00000001	--	--	--	--
Barium	83	0.032	1.00E-06	2.66E-06	80	5.6	7	1.14E-04	7	1.36E-07	0.0005	0.0003	--	--	--	--
Cadmium	1.05	0.032	1.00E-06	3.36E-08	80	5.6	7	1.14E-04	7	1.72E-09	0.00002	0.00009	70	1.72E-10	1.8	3E-10
Chromium (total)	13	0.032	1.00E-06	4.16E-07	80	5.6	7	1.14E-04	7	2.13E-08	5	0.000000004	--	--	--	--
Lead	98	0.032	1.00E-06	3.14E-06	80	5.6	7	1.14E-04	7	1.60E-07	0.001	0.0002	--	--	--	--
Mercury	0.15	0.032	1.00E-06	4.80E-09	80	5.6	7	1.14E-04	7	2.45E-10	0.0003	0.0000008	--	--	--	--
Selenium	0.92	0.032	1.00E-06	2.94E-08	80	5.6	7	1.14E-04	7	1.51E-09	0.003	0.0000005	--	--	--	--
PCB (Aroclor 1254)	0.908	0.032	1.00E-06	2.91E-08	80	5.6	7	1.14E-04	7	1.49E-09	0.00002	0.00007	70	1.49E-10	0.1	1E-11
Total									HI =			0.0006	Risk =			4E-10

Adult Exposure (ages 15 to 31)

Constituent	C_{soil} (mg/kg)	PM_{10} (mg/m^3)	CF (kg/mg)	C_{air} (mg/m^3)	EF (events/yr)	ED (hr/event)	EP (yr)	CF (yr/hr)	AP (nc) (yr)	ADE (nc) (mg/m^3)	RfC (mg/m^3)	HQ (unitless)	AP [ca] (yr)	ADE [ca] (mg/m^3)	UR $[(mg/m^3)^{-1}]$	Risk (unitless)
Acenaphthene	0.191	0.032	1.00E-06	6.11E-09	80	5.6	16	1.14E-04	16	3.13E-10	0.05	0.000000006	--	--	--	--
Anthracene	0.203	0.032	1.00E-06	6.50E-09	80	5.6	16	1.14E-04	16	3.32E-10	0.05	0.000000007	--	--	--	--
Benzo(a)anthracene	0.255	0.032	1.00E-06	8.16E-09	80	5.6	16	1.14E-04	16	4.17E-10	0.05	0.000000008	70	9.54E-11	0.21	2.0031E-11
Benzo(b)fluoranthene	0.274	0.032	1.00E-06	8.77E-09	80	5.6	16	1.14E-04	16	4.48E-10	0.05	0.000000009	70	1.02E-10	0.21	2E-11
Benzo(k)fluoranthene	0.218	0.032	1.00E-06	6.98E-09	80	5.6	16	1.14E-04	16	3.57E-10	0.05	0.000000007	70	8.15E-11	0.021	2E-12
Benzo(g,h,i)perylene	0.213	0.032	1.00E-06	6.82E-09	80	5.6	16	1.14E-04	16	3.49E-10	0.05	0.000000007	--	--	--	--
Benzo(a)pyrene	0.249	0.032	1.00E-06	7.97E-09	80	5.6	16	1.14E-04	16	4.07E-10	0.05	0.000000008	70	9.31E-11	2.1	2E-10
Chrysene	0.246	0.032	1.00E-06	7.87E-09	80	5.6	16	1.14E-04	16	4.03E-10	0.05	0.000000008	70	9.20E-11	0.021	2E-12
Fluoranthene	0.329	0.032	1.00E-06	1.05E-08	80	5.6	16	1.14E-04	16	5.38E-10	0.05	0.00000001	--	--	--	--
Fluorene	0.191	0.032	1.00E-06	6.11E-09	80	5.6	16	1.14E-04	16	3.13E-10	0.05	0.000000006	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.208	0.032	1.00E-06	6.66E-09	80	5.6	16	1.14E-04	16	3.40E-10	0.05	0.000000007	70	7.78E-11	0.21	2E-11
Phenanthrene	0.274	0.032	1.00E-06	8.77E-09	80	5.6	16	1.14E-04	16	4.48E-10	0.05	0.000000009	--	--	--	--
Pyrene	0.351	0.032	1.00E-06	1.12E-08	80	5.6	16	1.14E-04	16	5.74E-10	0.05	0.00000001	--	--	--	--
Barium	83	0.032	1.00E-06	2.66E-06	80	5.6	16	1.14E-04	16	1.36E-07	0.0005	0.0003	--	--	--	--
Cadmium	1.05	0.032	1.00E-06	3.36E-08	80	5.6	16	1.14E-04	16	1.72E-09	0.00002	0.00009	70	3.93E-10	1.8	7E-10
Chromium (total)	13	0.032	1.00E-06	4.16E-07	80	5.6	16	1.14E-04	16	2.13E-08	5	0.000000004	--	--	--	--
Lead	98	0.032	1.00E-06	3.14E-06	80	5.6	16	1.14E-04	16	1.60E-07	0.001	0.0002	--	--	--	--
Mercury	0.15	0.032	1.00E-06	4.80E-09	80	5.6	16	1.14E-04	16	2.45E-10	0.0003	0.0000008	--	--	--	--
Selenium	0.92	0.032	1.00E-06	2.94E-08	80	5.6	16	1.14E-04	16	1.51E-09	0.003	0.0000005	--	--	--	--
PCB (Aroclor 1254)	0.908	0.032	1.00E-06	2.91E-08	80	5.6	16	1.14E-04	16	1.49E-09	0.00002	0.00007	70	3.40E-10	0.1	3E-11
Total									HI =			0.0006	Risk =			1E-09

Combined Ages (1 to 31)

Total Risk	2E-09

APPENDIX B
TABLE B-7
RISK CHARACTERIZATION
SURFACE WATER INGESTION
TRESPASSERS
Former McCoy Field Wetland Area
New Bedford, Massachusetts

Equation: **ADD =** $\frac{C_{sw}\ IR_{sw}\ RAFo\ EF\ ED\ EP\ CF}{BW\ AP}$

HQ = ADD/RfD
HI = Sum [HQ]
Risk = ADD x SF

where:
- ADD = Average daily dose (mg/kg-dy)
- C_{sw} = Constituent concentration in surface water (mg/L)
- IR_{sw} = Surface water ingestion rate (L/dy)
- RAFo = Oral relative absorption factor (unitless)
- EF = Exposure frequency (events/year)
- ED = Exposure duration (day/event)
- EP = Exposure period (yr)
- CF = Unit conversion factor (yr/dy)
- BW = Body weight (kg)
- AP = Averaging period (yr) (nc = non-carcinogen; ca = carcinogen)

where:
- HQ = Non-carcinogenic hazard quotient (unitless)
- HI = Total hazard index (unitless)
- Risk = Excess lifetime cancer risk (unitless)
- RfD= Reference dose (mg/kg-dy)
- SF = Cancer slope factor [(mg/kg-dy)$^{-1}$]

Child Exposure (ages 1 to 8)

Constituent	C_{sw} (mg/L)	IR_{sw} (L/dy)	RAFo (unitless)	EF (events/yr)	ED (dy/event)	EP (yr)	CF (yr/dy)	BW (kg)	AP (nc) (yr)	ADD (nc) (mg/kg-dy)	RfD (mg/kg-dy)	HQ (unitless)	AP [ca] (yr)	ADD [ca] (mg/kg-dy)	SF [(mg/kg-dy)$^{-1}$]	Risk (unitless)
Acenaphthene	2.56E-05	0.05	1	80	1	7	2.74E-03	17	7	1.65E-08	0.06	0.0000003	--	--	--	--
Anthracene	8.41E-06	0.05	1	80	1	7	2.74E-03	17	7	5.42E-09	0.3	0.00000002	--	--	--	--
Benzo(a)anthracene	7.96E-07	0.05	1	80	1	7	2.74E-03	17	7	5.13E-10	0.03	0.00000002	70	5.13E-11	0.73	4E-11
Benzo(b)fluoranthene	1.20E-06	0.05	1	80	1	7	2.74E-03	17	7	7.71E-10	0.03	0.00000003	70	7.71E-11	0.73	6E-11
Benzo(k)fluoranthene	5.74E-07	0.05	1	80	1	7	2.74E-03	17	7	3.70E-10	0.03	0.00000001	70	3.70E-11	0.073	3E-12
Benzo(g,h,i)perylene	2.18E-07	0.05	1	80	1	7	2.74E-03	17	7	1.41E-10	0.03	0.000000005	--	--	--	--
Benzo(a)pyrene	6.05E-07	0.05	1	80	1	7	2.74E-03	17	7	3.90E-10	0.03	0.00000001	70	3.90E-11	7.3	3E-10
Chrysene	9.62E-07	0.05	1	80	1	7	2.74E-03	17	7	6.20E-10	0.03	0.00000002	70	6.20E-11	0.073	5E-12
Fluoranthene	3.77E-06	0.05	1	80	1	7	2.74E-03	17	7	2.43E-09	0.04	0.00000006	--	--	--	--
Fluorene	1.56E-05	0.05	1	80	1	7	2.74E-03	17	7	1.01E-08	0.04	0.0000003	--	--	--	--
Indeno(1,2,3-cd)pyrene	8.28E-08	0.05	1	80	1	7	2.74E-03	17	7	5.34E-11	0.03	0.000000002	70	5.34E-12	0.73	4E-12
Phenanthrene	1.07E-05	0.05	1	80	1	7	2.74E-03	17	7	6.91E-09	0.03	0.0000002	--	--	--	--
Pyrene	4.35E-06	0.05	1	80	1	7	2.74E-03	17	7	2.80E-09	0.03	0.00000009	--	--	--	--
Barium	2.63E-02	0.05	1	80	1	7	2.74E-03	17	7	1.69E-05	0.07	0.0002	--	--	--	--
Cadmium	5.26E-05	0.05	1	80	1	7	2.74E-03	17	7	3.39E-08	0.001	0.00003	--	--	--	--
Chromium (total)	1.72E-05	0.05	1	80	1	7	2.74E-03	17	7	1.11E-08	1.5	0.000000007	--	--	--	--
Lead	2.46E-04	0.05	1	80	1	7	2.74E-03	17	7	1.59E-07	0.00075	0.0002	--	--	--	--
Mercury	1.89E-06	0.05	1	80	1	7	2.74E-03	17	7	1.22E-09	0.0003	0.000004	--	--	--	--
Selenium	2.31E-05	0.05	1	80	1	7	2.74E-03	17	7	1.49E-08	0.005	0.000003	--	--	--	--
PCB (Aroclor 1254)	2.90E-07	0.05	1	80	1	7	2.74E-03	17	7	1.87E-10	0.00002	0.00001	70	1.87E-11	2	4E-11
Total									**HI =**			**0.0005**	**Risk =**			**4E-10**

APPENDIX B
TABLE B-7
RISK CHARACTERIZATION
SURFACE WATER INGESTION
TRESPASSERS
Former McCoy Field Wetland Area
New Bedford, Massachusetts

Youth Exposure (ages 8 to 15)

Constituent	C_{sw} (mg/L)	IR_{sw} (L/dy)	RAFo (unitless)	EF (events/yr)	ED (dy/event)	EP (yr)	CF (yr/dy)	BW (kg)	AP (nc) (yr)	ADD (nc) (mg/kg-dy)	RfD (mg/kg-dy)	HQ (unitless)	AP [ca] (yr)	ADD [ca] (mg/kg-dy)	SF [(mg/kg-dy)$^{-1}$]	Risk (unitless)
Acenaphthene	2.56E-05	0.05	1	80	1	7	2.74E-03	39.9	7	7.02E-09	0.06	0.00000012	--	--	--	--
Anthracene	8.41E-06	0.05	1	80	1	7	2.74E-03	39.9	7	2.31E-09	0.3	0.000000008	--	--	--	--
Benzo(a)anthracene	7.96E-07	0.05	1	80	1	7	2.74E-03	39.9	7	2.19E-10	0.03	0.000000007	70	2.19E-11	0.73	2E-11
Benzo(b)fluoranthene	1.20E-06	0.05	1	80	1	7	2.74E-03	39.9	7	3.28E-10	0.03	0.00000001	70	3.28E-11	0.73	2E-11
Benzo(k)fluoranthene	5.74E-07	0.05	1	80	1	7	2.74E-03	39.9	7	1.58E-10	0.03	0.000000005	70	1.58E-11	0.073	1E-12
Benzo(g,h,i)perylene	2.18E-07	0.05	1	80	1	7	2.74E-03	39.9	7	5.99E-11	0.03	0.000000002	--	--	--	--
Benzo(a)pyrene	6.05E-07	0.05	1	80	1	7	2.74E-03	39.9	7	1.66E-10	0.03	0.000000006	70	1.66E-11	7.3	1E-10
Chrysene	9.62E-07	0.05	1	80	1	7	2.74E-03	39.9	7	2.64E-10	0.03	0.00000001	70	2.64E-11	0.073	2E-12
Fluoranthene	3.77E-06	0.05	1	80	1	7	2.74E-03	39.9	7	1.04E-09	0.04	0.00000003	--	--	--	--
Fluorene	1.56E-05	0.05	1	80	1	7	2.74E-03	39.9	7	4.28E-09	0.04	0.0000001	--	--	--	--
Indeno(1,2,3-cd)pyrene	8.28E-08	0.05	1	80	1	7	2.74E-03	39.9	7	2.27E-11	0.03	0.0000000008	70	2.27E-12	0.73	2E-12
Phenanthrene	1.07E-05	0.05	1	80	1	7	2.74E-03	39.9	7	2.94E-09	0.03	0.0000001	--	--	--	--
Pyrene	4.35E-06	0.05	1	80	1	7	2.74E-03	39.9	7	1.19E-09	0.03	0.00000004	--	--	--	--
Barium	2.63E-02	0.05	1	80	1	7	2.74E-03	39.9	7	7.21E-06	0.07	0.0001	--	--	--	--
Cadmium	5.26E-05	0.05	1	80	1	7	2.74E-03	39.9	7	1.45E-08	0.001	0.00001	--	--	--	--
Chromium (total)	1.72E-05	0.05	1	80	1	7	2.74E-03	39.9	7	4.73E-09	1.5	0.000000003	--	--	--	--
Lead	2.46E-04	0.05	1	80	1	7	2.74E-03	39.9	7	6.76E-08	0.00075	0.00009	--	--	--	--
Mercury	1.89E-06	0.05	1	80	1	7	2.74E-03	39.9	7	5.19E-10	0.0003	0.000002	--	--	--	--
Selenium	2.31E-05	0.05	1	80	1	7	2.74E-03	39.9	7	6.35E-09	0.005	0.000001	--	--	--	--
PCB (Aroclor 1254)	2.90E-07	0.05	1	80	1	7	2.74E-03	39.9	7	7.96E-11	0.00002	0.000004	70	7.96E-12	2	2E-11
Total									**HI =**			**0.0002**	**Risk =**			**2E-10**

Adult Exposure (ages 15 to 31)

Constituent	C_{sw} (mg/L)	IR_{sw} (L/dy)	RAFo (unitless)	EF (events/yr)	ED (dy/event)	EP (yr)	CF (yr/dy)	BW (kg)	AP (nc) (yr)	ADD (nc) (mg/kg-dy)	RfD (mg/kg-dy)	HQ (unitless)	AP [ca] (yr)	ADD [ca] (mg/kg-dy)	SF [(mg/kg-dy)$^{-1}$]	Risk (unitless)
Acenaphthene	2.56E-05	0.05	1	80	1	16	2.74E-03	58.7	16	4.77E-09	0.06	0.00000008	--	--	--	--
Anthracene	8.41E-06	0.05	1	80	1	16	2.74E-03	58.7	16	1.57E-09	0.3	0.000000005	--	--	--	--
Benzo(a)anthracene	7.96E-07	0.05	1	80	1	16	2.74E-03	58.7	16	1.49E-10	0.03	0.000000005	70	3.40E-11	0.73	2E-11
Benzo(b)fluoranthene	1.20E-06	0.05	1	80	1	16	2.74E-03	58.7	16	2.23E-10	0.03	0.000000007	70	5.10E-11	0.73	4E-11
Benzo(k)fluoranthene	5.74E-07	0.05	1	80	1	16	2.74E-03	58.7	16	1.07E-10	0.03	0.000000004	70	2.45E-11	0.073	2E-12
Benzo(g,h,i)perylene	2.18E-07	0.05	1	80	1	16	2.74E-03	58.7	16	4.07E-11	0.03	0.000000001	--	--	--	--
Benzo(a)pyrene	6.05E-07	0.05	1	80	1	16	2.74E-03	58.7	16	1.13E-10	0.03	0.000000004	70	2.58E-11	7.3	2E-10
Chrysene	9.62E-07	0.05	1	80	1	16	2.74E-03	58.7	16	1.80E-10	0.03	0.000000006	70	4.11E-11	0.073	3E-12
Fluoranthene	3.77E-06	0.05	1	80	1	16	2.74E-03	58.7	16	7.04E-10	0.04	0.00000002	--	--	--	--
Fluorene	1.56E-05	0.05	1	80	1	16	2.74E-03	58.7	16	2.91E-09	0.04	0.00000007	--	--	--	--
Indeno(1,2,3-cd)pyrene	8.28E-08	0.05	1	80	1	16	2.74E-03	58.7	16	1.55E-11	0.03	0.0000000005	70	3.53E-12	0.73	3E-12
Phenanthrene	1.07E-05	0.05	1	80	1	16	2.74E-03	58.7	16	2.00E-09	0.03	0.00000007	--	--	--	--
Pyrene	4.35E-06	0.05	1	80	1	16	2.74E-03	58.7	16	8.12E-10	0.03	0.00000003	--	--	--	--
Barium	2.63E-02	0.05	1	80	1	16	2.74E-03	58.7	16	4.90E-06	0.07	0.00007	--	--	--	--
Cadmium	5.26E-05	0.05	1	80	1	16	2.74E-03	58.7	16	9.83E-09	0.001	0.00001	--	--	--	--
Chromium (total)	1.72E-05	0.05	1	80	1	16	2.74E-03	58.7	16	3.22E-09	1.5	0.000000002	--	--	--	--
Lead	2.46E-04	0.05	1	80	1	16	2.74E-03	58.7	16	4.60E-08	0.00075	0.00006	--	--	--	--
Mercury	1.89E-06	0.05	1	80	1	16	2.74E-03	58.7	16	3.53E-10	0.0003	0.000001	--	--	--	--
Selenium	2.31E-05	0.05	1	80	1	16	2.74E-03	58.7	16	4.31E-09	0.005	0.0000009	--	--	--	--
PCB (Aroclor 1254)	2.90E-07	0.05	1	80	1	16	2.74E-03	58.7	16	5.41E-11	0.00002	0.000003	70	1.24E-11	2	2E-11
Total									**HI =**			**0.0001**	**Risk =**			**3E-10**

Combined ages (1 to 31)

Total Risk	**9E-10**

APPENDIX B
TABLE B-8
RISK CHARACTERIZATION
SURFACE WATER DERMAL CONTACT
TRESPASSERS
Former McCoy Field Wetland Area
New Bedford, Massachusetts

Equation: $$ADD = \frac{C_{SW} \times SA \times Kp \times EF \times EP \times CF}{BW \times AP}$$

HQ = ADD/RfD
HI = Sum [HQ]
Risk = ADD x SF

where:
- ADD = Average daily dose (mg/kg-dy) (nc = non-carcinogen; ca = carcinogen)
- C_{SW} = Constituent concentration in surface water (mg/L)
- SA = Exposed skin surface area (cm^2)
- DA_{event} = Dermal absorption per event per mg/cm^3 [$(mg/cm^2\text{-event})/(mg/L)$]
- EF = Exposure frequency (events/year)
- EP = Exposure period (yr)
- CF = Unit conversion factor (yr/dy)
- BW = Body weight (kg)
- AP = Averaging period (yr)

where:
- HQ = Non-carcinogenic hazard quotient (unitless)
- HI = Total hazard index (unitless)
- Risk = Excess lifetime cancer risk (unitless)
- RfD= Reference dose (mg/kg-dy)
- SF = Cancer slope factor $[(mg/kg\text{-}dy)^{-1}]$

Child Exposure (ages 1 to 8)

Constituent	C_{sw} (mg/L)	SA (cm^2)	DA_{event} [mg/cm^2-event]/[mg/L]	EF (events/yr)	EP (yr)	CF (yr/dy)	BW (kg)	AP (nc) (yr)	ADD (nc) (mg/kg-dy)	RfD (mg/kg-dy)	HQ (unitless)	AP [ca] (yr)	ADD [ca] (mg/kg-dy)	SF $[(mg/kg\text{-}dy)^{-1}]$	Risk (unitless)
Acenaphthene	2.56E-05	1,351	1.02E-04	80	7	2.74E-03	17	7	4.52E-08	0.06	0.0000008	--	--	--	--
Anthracene	8.41E-06	1,351	2.23E-04	80	7	2.74E-03	17	7	3.27E-08	0.3	0.0000001	--	--	--	--
Benzo(a)anthracene	7.96E-07	1,351	1.36E-03	80	7	2.74E-03	17	7	1.88E-08	0.03	0.0000006	70	1.88E-09	0.73	1E-09
Benzo(b)fluoranthene	1.20E-06	1,351	9.41E-04	80	7	2.74E-03	17	7	1.96E-08	0.03	0.0000007	70	1.96E-09	0.73	1E-09
Benzo(k)fluoranthene	5.74E-07	1,351	1.28E-03	80	7	2.74E-03	17	7	1.27E-08	0.03	0.0000004	70	1.27E-09	0.073	9E-11
Benzo(g,h,i)perylene	2.18E-07	1,351	2.45E-03	80	7	2.74E-03	17	7	9.32E-09	0.03	0.0000003	--	--	--	--
Benzo(a)pyrene	6.05E-07	1,351	1.37E-03	80	7	2.74E-03	17	7	1.45E-08	0.03	0.0000005	70	1.45E-09	7.3	1E-08
Chrysene	9.62E-07	1,351	6.84E-04	80	7	2.74E-03	17	7	1.15E-08	0.03	0.0000004	70	1.15E-09	0.073	8E-11
Fluoranthene	3.77E-06	1,351	5.37E-04	80	7	2.74E-03	17	7	3.53E-08	0.04	0.0000009	--	--	--	--
Fluorene	1.56E-05	1,351	1.40E-04	80	7	2.74E-03	17	7	3.79E-08	0.04	0.0000009	--	--	--	--
Indeno(1,2,3-cd)pyrene	8.28E-08	1,351	2.99E-03	80	7	2.74E-03	17	7	4.31E-09	0.03	0.0000001	70	4.31E-10	0.73	3E-10
Phenanthrene	1.07E-05	1,351	2.34E-04	80	7	2.74E-03	17	7	4.36E-08	0.03	0.000001	--	--	--	--
Pyrene	4.35E-06	1,351	5.05E-04	80	7	2.74E-03	17	7	3.83E-08	0.03	0.000001	--	--	--	--
Barium	2.63E-02	1,351	2.50E-07	80	7	2.74E-03	17	7	1.14E-07	0.07	0.000002	--	--	--	--
Cadmium	5.26E-05	1,351	2.50E-07	80	7	2.74E-03	17	7	2.29E-10	0.001	0.0000002	--	--	--	--
Chromium (total)	1.72E-05	1,351	2.50E-07	80	7	2.74E-03	17	7	7.50E-11	1.5	0.00000000005	--	--	--	--
Lead	2.46E-04	1,351	2.50E-07	80	7	2.74E-03	17	7	1.07E-09	0.00075	0.000001	--	--	--	--
Mercury	1.89E-06	1,351	2.50E-07	80	7	2.74E-03	17	7	8.22E-12	0.0003	0.00000003	--	--	--	--
Selenium	2.31E-05	1,351	2.50E-07	80	7	2.74E-03	17	7	1.01E-10	0.005	0.00000002	--	--	--	--
PCB (Aroclor 1254)	2.90E-07	1,351	3.31E-04	80	7	2.74E-03	17	7	1.67E-09	0.00002	0.0001	70	1.67E-10	2	3E-10
Total								**HI =**			**0.0001**	**Risk =**			**1E-08**

APPENDIX B
TABLE B-8
RISK CHARACTERIZATION
SURFACE WATER DERMAL CONTACT
TRESPASSERS
Former McCoy Field Wetland Area
New Bedford, Massachusetts

Youth Exposure (ages 8 to 15)

Constituent	C_{sw} (mg/L)	SA (cm^2)	DA_{event} [mg/cm^2-event]/[mg/L]	EF (events/yr)	EP (yr)	CF (yr/dy)	BW (kg)	AP (nc) (yr)	ADD (nc) (mg/kg-dy)	RfD (mg/kg-dy)	HQ (unitless)	AP [ca] (yr)	ADD [ca] (mg/kg-dy)	SF [(mg/kg-dy)$^{-1}$]	Risk (unitless)
Acenaphthene	2.56E-05	2,928	1.02E-04	80	7	2.74E-03	39.9	7	4.17E-08	0.06	0.0000007	--	--	--	--
Anthracene	8.41E-06	2,928	2.23E-04	80	7	2.74E-03	39.9	7	3.02E-08	0.3	0.0000001	--	--	--	--
Benzo(a)anthracene	7.96E-07	2,928	1.36E-03	80	7	2.74E-03	39.9	7	1.74E-08	0.03	0.0000006	70	1.74E-09	0.73	1E-09
Benzo(b)fluoranthene	1.20E-06	2,928	9.41E-04	80	7	2.74E-03	39.9	7	1.81E-08	0.03	0.0000006	70	1.81E-09	0.73	1E-09
Benzo(k)fluoranthene	5.74E-07	2,928	1.28E-03	80	7	2.74E-03	39.9	7	1.18E-08	0.03	0.0000004	70	1.18E-09	0.073	9E-11
Benzo(g,h,i)perylene	2.18E-07	2,928	2.45E-03	80	7	2.74E-03	39.9	7	8.61E-09	0.03	0.0000003	--	--	--	--
Benzo(a)pyrene	6.05E-07	2,928	1.37E-03	80	7	2.74E-03	39.9	7	1.34E-08	0.03	0.0000004	70	1.34E-09	7.3	1E-08
Chrysene	9.62E-07	2,928	6.84E-04	80	7	2.74E-03	39.9	7	1.06E-08	0.03	0.0000004	70	1.06E-09	0.073	8E-11
Fluoranthene	3.77E-06	2,928	5.37E-04	80	7	2.74E-03	39.9	7	3.26E-08	0.04	0.0000008	--	--	--	--
Fluorene	1.56E-05	2,928	1.40E-04	80	7	2.74E-03	39.9	7	3.50E-08	0.04	0.0000009	--	--	--	--
Indeno(1,2,3-cd)pyrene	8.28E-08	2,928	2.99E-03	80	7	2.74E-03	39.9	7	3.98E-09	0.03	0.0000001	70	3.98E-10	0.73	3E-10
Phenanthrene	1.07E-05	2,928	2.34E-04	80	7	2.74E-03	39.9	7	4.03E-08	0.03	0.000001	--	--	--	--
Pyrene	4.35E-06	2,928	5.05E-04	80	7	2.74E-03	39.9	7	3.54E-08	0.03	0.000001	--	--	--	--
Barium	2.63E-02	2,928	2.50E-07	80	7	2.74E-03	39.9	7	1.06E-07	0.07	0.000002	--	--	--	--
Cadmium	5.26E-05	2,928	2.50E-07	80	7	2.74E-03	39.9	7	2.12E-10	0.001	0.0000002	--	--	--	--
Chromium (total)	1.72E-05	2,928	2.50E-07	80	7	2.74E-03	39.9	7	6.93E-11	1.5	0.00000000005	--	--	--	--
Lead	2.46E-04	2,928	2.50E-07	80	7	2.74E-03	39.9	7	9.90E-10	0.00075	0.000001	--	--	--	--
Mercury	1.89E-06	2,928	2.50E-07	80	7	2.74E-03	39.9	7	7.59E-12	0.0003	0.00000003	--	--	--	--
Selenium	2.31E-05	2,928	2.50E-07	80	7	2.74E-03	39.9	7	9.29E-11	0.005	0.00000002	--	--	--	--
PCB (Aroclor 1254)	2.90E-07	2,928	3.31E-04	80	7	2.74E-03	39.9	7	1.54E-09	0.00002	0.0001	70	1.54E-10	2	3E-10
Total								**HI =**			**0.0001**	**Risk =**			**1E-08**

Adult Exposure (ages 15 to 31)

Constituent	C_{sw} (mg/L)	SA (cm^2)	DA_{event} [mg/cm^2-event]/[mg/L]	EF (events/yr)	EP (yr)	CF (yr/dy)	BW (kg)	AP (nc) (yr)	ADD (nc) (mg/kg-dy)	RfD (mg/kg-dy)	HQ (unitless)	AP [ca] (yr)	ADD [ca] (mg/kg-dy)	SF [(mg/kg-dy)$^{-1}$]	Risk (unitless)
Acenaphthene	2.56E-05	3,107	1.02E-04	80	16	2.74E-03	58.7	16	3.01E-08	0.06	0.0000005	--	--	--	--
Anthracene	8.41E-06	3,107	2.23E-04	80	16	2.74E-03	58.7	16	2.18E-08	0.3	0.00000007	--	--	--	--
Benzo(a)anthracene	7.96E-07	3,107	1.36E-03	80	16	2.74E-03	58.7	16	1.25E-08	0.03	0.0000004	70	2.86E-09	0.73	2E-09
Benzo(b)fluoranthene	1.20E-06	3,107	9.41E-04	80	16	2.74E-03	58.7	16	1.30E-08	0.03	0.0000004	70	2.98E-09	0.73	2E-09
Benzo(k)fluoranthene	5.74E-07	3,107	1.28E-03	80	16	2.74E-03	58.7	16	8.49E-09	0.03	0.0000003	70	1.94E-09	0.073	1E-10
Benzo(g,h,i)perylene	2.18E-07	3,107	2.45E-03	80	16	2.74E-03	58.7	16	6.21E-09	0.03	0.0000002	--	--	--	--
Benzo(a)pyrene	6.05E-07	3,107	1.37E-03	80	16	2.74E-03	58.7	16	9.64E-09	0.03	0.0000003	70	2.20E-09	7.3	2E-08
Chrysene	9.62E-07	3,107	6.84E-04	80	16	2.74E-03	58.7	16	7.64E-09	0.03	0.0000003	70	1.75E-09	0.073	1E-10
Fluoranthene	3.77E-06	3,107	5.37E-04	80	16	2.74E-03	58.7	16	2.35E-08	0.04	0.0000006	--	--	--	--
Fluorene	1.56E-05	3,107	1.40E-04	80	16	2.74E-03	58.7	16	2.52E-08	0.04	0.0000006	--	--	--	--
Indeno(1,2,3-cd)pyrene	8.28E-08	3,107	2.99E-03	80	16	2.74E-03	58.7	16	2.87E-09	0.03	0.0000001	70	6.57E-10	0.73	5E-10
Phenanthrene	1.07E-05	3,107	2.34E-04	80	16	2.74E-03	58.7	16	2.90E-08	0.03	0.000001	--	--	--	--
Pyrene	4.35E-06	3,107	5.05E-04	80	16	2.74E-03	58.7	16	2.55E-08	0.03	0.0000008	--	--	--	--
Barium	2.63E-02	3,107	2.50E-07	80	16	2.74E-03	58.7	16	7.62E-08	0.07	0.000001	--	--	--	--
Cadmium	5.26E-05	3,107	2.50E-07	80	16	2.74E-03	58.7	16	1.53E-10	0.001	0.0000002	--	--	--	--
Chromium (total)	1.72E-05	3,107	2.50E-07	80	16	2.74E-03	58.7	16	5.00E-11	1.5	0.00000000003	--	--	--	--
Lead	2.46E-04	3,107	2.50E-07	80	16	2.74E-03	58.7	16	7.14E-10	0.00075	0.000001	--	--	--	--
Mercury	1.89E-06	3,107	2.50E-07	80	16	2.74E-03	58.7	16	5.48E-12	0.0003	0.00000002	--	--	--	--
Selenium	2.31E-05	3,107	2.50E-07	80	16	2.74E-03	58.7	16	6.70E-11	0.005	0.00000001	--	--	--	--
PCB (Aroclor 1254)	2.90E-07	3,107	3.31E-04	80	16	2.74E-03	58.7	16	1.11E-09	0.00002	0.00006	70	2.54E-10	2	5E-10
Total								**HI =**			**0.00006**	**Risk =**			**2E-08**

Combined ages (1 to 31)

Total Risk	**5E-08**

APPENDIX B
TABLE B-9
SUMMARY OF CHEMICAL-SPECIFIC INPUT VARIABLES
Former McCoy Field Wetland Area
New Bedford, Massachusetts

Constituent	Soil Exposure Point Concentrations	Estimated Surface Water Exposure Point Concentrations[1]	Relative Absorption Factor[2] (RAF_o)			
	C_{soil} (mg/kg)	C_{sw} (mg/L)	Soil Ingestion (EPA) (unitless)	Soil Ingestion (MADEP) (unitless)	Soil Dermal (unitless)	Surface Water (unitless)
Acenaphthene	0.191	2.56E-05	1	0.36	0.1	1
Anthracene	0.203	8.41E-06	1	0.36	0.1	1
Benzo(a)anthracene	0.255	7.96E-07	1	0.28	0.02	1
Benzo(b)fluoranthene	0.274	1.20E-06	1	0.28	0.02	1
Benzo(k)fluoranthene	0.218	5.74E-07	1	0.28	0.02	1
Benzo(g,h,i)perylene	0.213	2.18E-07	1	0.36	0.1	1
Benzo(a)pyrene	0.249	6.05E-07	1	0.28	0.02	1
Chrysene	0.246	9.62E-07	1	0.36	0.02	1
Fluoranthene	0.329	3.77E-06	1	0.36	0.1	1
Fluorene	0.191	1.56E-05	1	0.36	0.1	1
Indeno(1,2,3-cd)pyrene	0.208	8.28E-08	1	0.28	0.02	1
Phenanthrene	0.274	1.07E-05	1	0.36	0.1	1
Pyrene	0.351	4.35E-06	1	0.36	0.1	1
Barium	83	2.63E-02	1	1	0.05	1
Cadmium	1.05	5.26E-05	1	1	0.14	1
Chromium (total)	13	1.72E-05	1	1	0.04	1
Lead	98	2.46E-04	1	0.5	0.006	1
Mercury	0.15	1.89E-06	1	1	0.05	1
Selenium	0.92	2.31E-05	1	1	0.002	1
PCB (Aroclor 1254)	0.908	2.90E-07	1	0.85	0.16	1

1. Calculated on separate sheet.

2. MADEP (2004). Proposed Revised Method 1 Numerical Standards and supporting documentation. September.

APPENDIX B
TABLE B-10
SUMMARY OF EXPOSURE FACTORS
TRESPASSERS
Former McCoy Field Wetland Area
New Bedford, Massachusetts

Notation	Parameter	Value	Units	Reference
IR_{soil}	Soil ingestion rate - child	0.0001	kg/day	MADEP (1995).
	Soil ingestion rate - youth	0.00005	kg/day	MADEP (1995).
	Soil ingestion rate - adult	0.00005	kg/day	MADEP (1995).
IR_{SW}	Surface water ingestion rate	0.05	L/day	MADEP (1995).
SA	Exposed skin surface area (child)	1,351	cm^2	MADEP (2002a), corresponds to exposure of hands, forearms and feet.
	Exposed skin surface area (youth)	2,928	cm^2	MADEP (2002a), corresponds to exposure of hands, forearms and feet.
	Exposed skin surface area (adult)	3,107	cm^2	MADEP (2002a), corresponds to exposure of hands, forearms and feet.
AF_{soil}	Soil adherence factor (child)	5.20E-07	kg/cm^2	Calculated from data in MADEP (2002a).
	Soil adherence factor (youth)	1.40E-07	kg/cm^2	MADEP (2002a), corresponds to exposure of hands, forearms and feet.
	Soil adherence factor (adult)	1.00E-07	kg/cm^2	Calculated from data in MADEP (2002a).
PM_{10}	Particulate matter concentration in air	0.032	mg/m^3	MADEP (1995); value for open field air PM_{10} concentrations.
EF	Exopsure frequency	80	events/yr	Four days per week in June, July, August and 2 days per week in April, May, September, October.
ED	Exposure duration (soil, sediment)	1	dy/event	Conventional value.
	Exposure duration (surface water, air)	5.6	hr/event	From U.S. EPA (1997).
EP	Exposure period (child)	7	yr	Age-specific exposure period.
	Exposure period (youth)	7	yr	Age-specific exposure period.
	Exposure period (adult)	16	yr	Age-specific exposure period.
AP	Averaging period (child) (non-carcinogenic)	7	yr	Same as exposure period.
	Averaging period (youth) (non-carcinogenic)	7	yr	Same as exposure period.
	Averaging period (adult) (non-carcinogenic)	16	yr	Same as exposure period.
	Averaging period (all) (carcinogenic)	70	yr	Conventional lifetime averaging for carcinogens.
BW	Body weight (child)	17	kg	Average weight for age group (MADEP 2004).
	Body weight (youth)	39.9	kg	Average weight for age group (MADEP 2004).
	Body weight (adult)	58.7	kg	Average weight for age group (MADEP 2004).
CF	Unit conversion factor	1.00E-06	kg/mg	Unit conversion.
	Unit conversion factor	0.001	L/cm^3	Unit conversion.
	Unit conversion factor	2.74E-03	yr/dy	Unit conversion.
	Unit conversion factor	1.14E-04	yr/hr	Unit conversion.

MADEP (1995). Guidance for Disposal Site Risk Characterization in Support of the Massachusetts Contingency Plan. Interim Final Policy WSC/ORS-95-141, July.
MADEP (2004). Proposed revised Method 1 Numerical Standards (and supporting documentation). September.
MADEP (2002a). Technical Update: Weighted Skin-Soil Adherence Factors. April.
U.S. EPA (1997). Exposure Factors Handbook. EPA/600/P-95-002F. April.

Appendix C
ProUCL Upper Confidence Limit Summaries

General Statistics

Data File	J:\B345-000 Beta McCoy\Risk Stuff\Wetlands	Variable:	Total PCBs

Raw Statistics	
Number of Valid Samples	128
Number of Unique Samples	109
Minimum	3.5
Maximum	11800
Mean	968.168
Median	120.5
Standard Deviation	2031.641
Variance	4127564
Coefficient of Variation	2.098438
Skewness	3.237643

Gamma Statistics	
k hat	0.391493
k star (bias corrected)	0.387526
Theta hat	2473.015
Theta star	2498.332
nu hat	100.2222
nu star	99.20657
Approx.Chi Square Value (.05)	77.22447
Adjusted Level of Significance	0.048125
Adjusted Chi Square Value	77.00485

Log-transformed Statistics	
Minimum of log data	1.252763
Maximum of log data	9.375855
Mean of log data	5.188726
Standard Deviation of log data	1.954951
Variance of log data	3.821832

RECOMMENDATION
Data are Non-parametric (0.05)
Use 97.5% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.317457
Lilliefors 5% Critical Value	0.078312
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	1265.71

Gamma Distribution Test	
A-D Test Statistic	5.391085
A-D 5% Critical Value	0.845668
K-S Test Statistic	0.175941
K-S 5% Critical Value	0.088209
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	1243.759
Adjusted Gamma UCL	1247.306

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.085815
Lilliefors 5% Critical Value	0.078312
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	2105.459
95% Chebyshev (MVUE) UCL	2551.743
97.5% Chebyshev (MVUE) UCL	3153.101
99% Chebyshev (MVUE) UCL	4334.352

95% Non-parametric UCLs	
CLT UCL	1263.54
Adj-CLT UCL (Adjusted for skewness)	1318.449
Mod-t UCL (Adjusted for skewness)	1274.275
Jackknife UCL	1265.71
Standard Bootstrap UCL	1256.996
Bootstrap-t UCL	1337.161
Hall's Bootstrap UCL	1314.654
Percentile Bootstrap UCL	1266.559
BCA Bootstrap UCL	1338.297
95% Chebyshev (Mean, Sd) UCL	1750.91
97.5% Chebyshev (Mean, Sd) UCL	2089.603
99% Chebyshev (Mean, Sd) UCL	2754.9

General Statistics

Data File	J:\B345-000 Beta McCoy\Risk Stuff\Wetlands	Variable:	Anthracene

Raw Statistics	
Number of Valid Samples	122
Number of Unique Samples	64
Minimum	25
Maximum	2050
Mean	203.3566
Median	130
Standard Deviation	274.6393
Variance	75426.74
Coefficient of Variation	1.350531
Skewness	4.60292

Gamma Statistics	
k hat	1.398811
k star (bias corrected)	1.369879
Theta hat	145.3781
Theta star	148.4486
nu hat	341.3099
nu star	334.2504
Approx.Chi Square Value (.05)	292.8806
Adjusted Level of Significance	0.048033
Adjusted Chi Square Value	292.422

Log-transformed Statistics	
Minimum of log data	3.218876
Maximum of log data	7.625595
Mean of log data	4.916734
Standard Deviation of log data	0.812922
Variance of log data	0.660842

RECOMMENDATION

Data are lognormal (0.05)

Use H-UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.258033
Lilliefors 5% Critical Value	0.080215
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	244.5708

Gamma Distribution Test	
A-D Test Statistic	3.741105
A-D 5% Critical Value	0.772765
K-S Test Statistic	0.146855
K-S 5% Critical Value	0.085523
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	232.0809
Adjusted Gamma UCL	232.4449

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.071925
Lilliefors 5% Critical Value	0.080215
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	220.7732
95% Chebyshev (MVUE) UCL	258.6259
97.5% Chebyshev (MVUE) UCL	288.6032
99% Chebyshev (MVUE) UCL	347.4876

95% Non-parametric UCLs	
CLT UCL	244.2553
Adj-CLT UCL (Adjusted for skewness)	255.3271
Mod-t UCL (Adjusted for skewness)	246.2978
Jackknife UCL	244.5708
Standard Bootstrap UCL	243.4193
Bootstrap-t UCL	262.8563
Hall's Bootstrap UCL	276.3142
Percentile Bootstrap UCL	246.0861
BCA Bootstrap UCL	258.5
95% Chebyshev (Mean, Sd) UCL	311.7392
97.5% Chebyshev (Mean, Sd) UCL	358.6364
99% Chebyshev (Mean, Sd) UCL	450.7569

Data File	J:\B345-000 Beta McCoy\Risk Stuff\Wetlands	Variable:	Benzo(a)anthracene	

Raw Statistics	
Number of Valid Samples	122
Number of Unique Samples	65
Minimum	25
Maximum	2300
Mean	254.7418
Median	150
Standard Deviation	369.4532
Variance	136495.7
Coefficient of Variation	1.450305
Skewness	3.639634

Gamma Statistics	
k hat	1.152554
k star (bias corrected)	1.129677
Theta hat	221.0237
Theta star	225.4996
nu hat	281.2233
nu star	275.6413
Approx.Chi Square Value (.05)	238.1835
Adjusted Level of Significance	0.048033
Adjusted Chi Square Value	237.7709

Log-transformed Statistics	
Minimum of log data	3.218876
Maximum of log data	7.740664
Mean of log data	5.047375
Standard Deviation of log data	0.89592
Variance of log data	0.802673

RECOMMENDATION
Data are Non-parametric (0.05)
Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.278838
Lilliefors 5% Critical Value	0.080215
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	310.1845

Gamma Distribution Test	
A-D Test Statistic	5.793696
A-D 5% Critical Value	0.779188
K-S Test Statistic	0.184496
K-S 5% Critical Value	0.085992
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	294.8037
Adjusted Gamma UCL	295.3152

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.107589
Lilliefors 5% Critical Value	0.080215
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	275.7314
95% Chebyshev (MVUE) UCL	326.9201
97.5% Chebyshev (MVUE) UCL	368.2521
99% Chebyshev (MVUE) UCL	449.4408

95% Non-parametric UCLs	
CLT UCL	309.7601
Adj-CLT UCL (Adjusted for skewness)	321.5371
Mod-t UCL (Adjusted for skewness)	312.0215
Jackknife UCL	310.1845
Standard Bootstrap UCL	310.7558
Bootstrap-t UCL	333.3715
Hall's Bootstrap UCL	318.4108
Percentile Bootstrap UCL	310.7705
BCA Bootstrap UCL	321.0164
95% Chebyshev (Mean, Sd) UCL	400.5414
97.5% Chebyshev (Mean, Sd) UCL	463.629
99% Chebyshev (Mean, Sd) UCL	587.5524

Data File	J:\B345-000 Beta McCoy\Risk Stuff\Wetlands	Variable:	Benzo(a)pyrene

Raw Statistics	
Number of Valid Samples	122
Number of Unique Samples	65
Minimum	25
Maximum	2300
Mean	249.332
Median	137.5
Standard Deviation	368.7875
Variance	136004.3
Coefficient of Variation	1.479103
Skewness	3.689594

Gamma Statistics	
k hat	1.129364
k star (bias corrected)	1.107058
Theta hat	220.7719
Theta star	225.2204
nu hat	275.5649
nu star	270.1221
Approx.Chi Square Value (.05)	233.0533
Adjusted Level of Significance	0.048033
Adjusted Chi Square Value	232.6453

Log-transformed Statistics	
Minimum of log data	3.218876
Maximum of log data	7.740664
Mean of log data	5.014679
Standard Deviation of log data	0.902358
Variance of log data	0.814251

RECOMMENDATION
Data are Non-parametric (0.05)
Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.272951
Lilliefors 5% Critical Value	0.080215
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	304.6748

Gamma Distribution Test	
A-D Test Statistic	5.732254
A-D 5% Critical Value	0.779793
K-S Test Statistic	0.173771
K-S 5% Critical Value	0.086036
Data do not follow gamma distribution	
at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	288.99
Adjusted Gamma UCL	289.4968

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.093823
Lilliefors 5% Critical Value	0.080215
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	268.8588
95% Chebyshev (MVUE) UCL	319.0559
97.5% Chebyshev (MVUE) UCL	359.6514
99% Chebyshev (MVUE) UCL	439.3935

95% Non-parametric UCLs	
CLT UCL	304.2511
Adj-CLT UCL (Adjusted for skewness)	316.1683
Mod-t UCL (Adjusted for skewness)	306.5336
Jackknife UCL	304.6748
Standard Bootstrap UCL	304.4391
Bootstrap-t UCL	319.6562
Hall's Bootstrap UCL	316.1793
Percentile Bootstrap UCL	306.7992
BCA Bootstrap UCL	317.6025
95% Chebyshev (Mean, Sd) UCL	394.8689
97.5% Chebyshev (Mean, Sd) UCL	457.8428
99% Chebyshev (Mean, Sd) UCL	581.5429

General Statistics

Data File	J:\B345-000 Beta McCoy\Risk Stuff\Wetlands	Variable:	Chrysene

Raw Statistics	
Number of Valid Samples	122
Number of Unique Samples	65
Minimum	25
Maximum	2050
Mean	245.6025
Median	150
Standard Deviation	333.6182
Variance	111301.1
Coefficient of Variation	1.358367
Skewness	3.528294

Gamma Statistics	
k hat	1.235059
k star (bias corrected)	1.210153
Theta hat	198.8589
Theta star	202.9516
nu hat	301.3544
nu star	295.2774
Approx.Chi Square Value (.05)	256.4662
Adjusted Level of Significance	0.048033
Adjusted Chi Square Value	256.0377

Log-transformed Statistics	
Minimum of log data	3.218876
Maximum of log data	7.625595
Mean of log data	5.047103
Standard Deviation of log data	0.873659
Variance of log data	0.763279

RECOMMENDATION
Data are Non-parametric (0.05)
Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.267731
Lilliefors 5% Critical Value	0.080215
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	295.6675

Gamma Distribution Test	
A-D Test Statistic	5.149324
A-D 5% Critical Value	0.777036
K-S Test Statistic	0.17132
K-S 5% Critical Value	0.085835
Data do not follow gamma distribution	
at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	282.7696
Adjusted Gamma UCL	283.2428

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.097641
Lilliefors 5% Critical Value	0.080215
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	268.7445
95% Chebyshev (MVUE) UCL	317.6407
97.5% Chebyshev (MVUE) UCL	356.9093
99% Chebyshev (MVUE) UCL	434.0447

95% Non-parametric UCLs	
CLT UCL	295.2842
Adj-CLT UCL (Adjusted for skewness)	305.5937
Mod-t UCL (Adjusted for skewness)	297.2756
Jackknife UCL	295.6675
Standard Bootstrap UCL	294.0972
Bootstrap-t UCL	309.5599
Hall's Bootstrap UCL	303.6979
Percentile Bootstrap UCL	297.5492
BCA Bootstrap UCL	308.6557
95% Chebyshev (Mean, Sd) UCL	377.2603
97.5% Chebyshev (Mean, Sd) UCL	434.2287
99% Chebyshev (Mean, Sd) UCL	546.1322

Data File	J:\B345-000 Beta McCoy\Risk Stuff\Wetlands	Variable:	Fluorene

Raw Statistics	
Number of Valid Samples	122
Number of Unique Samples	62
Minimum	25
Maximum	2050
Mean	190.6434
Median	130
Standard Deviation	267.9776
Variance	71811.99
Coefficient of Variation	1.405648
Skewness	5.007586

Gamma Statistics	
k hat	1.448958
k star (bias corrected)	1.418793
Theta hat	131.5728
Theta star	134.3702
nu hat	353.5458
nu star	346.1854
Approx.Chi Square Value (.05)	304.0623
Adjusted Level of Significance	0.048033
Adjusted Chi Square Value	303.5948

Log-transformed Statistics	
Minimum of log data	3.218876
Maximum of log data	7.625595
Mean of log data	4.867224
Standard Deviation of log data	0.781127
Variance of log data	0.610159

RECOMMENDATION

Data are lognormal (0.05)

Use H-UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.268247
Lilliefors 5% Critical Value	0.080215
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	230.858

Gamma Distribution Test	
A-D Test Statistic	4.2328
A-D 5% Critical Value	0.771457
K-S Test Statistic	0.153513
K-S 5% Critical Value	0.085428
Data do not follow gamma distribution	
at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	217.0541
Adjusted Gamma UCL	217.3883

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.076043
Lilliefors 5% Critical Value	0.080215
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	203.303
95% Chebyshev (MVUE) UCL	237.0035
97.5% Chebyshev (MVUE) UCL	263.5079
99% Chebyshev (MVUE) UCL	315.5706

95% Non-parametric UCLs	
CLT UCL	230.5501
Adj-CLT UCL (Adjusted for skewness)	242.3031
Mod-t UCL (Adjusted for skewness)	232.6913
Jackknife UCL	230.858
Standard Bootstrap UCL	229.3676
Bootstrap-t UCL	258.6419
Hall's Bootstrap UCL	268.8789
Percentile Bootstrap UCL	232.8033
BCA Bootstrap UCL	250.2254
95% Chebyshev (Mean, Sd) UCL	296.3971
97.5% Chebyshev (Mean, Sd) UCL	342.1568
99% Chebyshev (Mean, Sd) UCL	432.0428

Data File	J:\B345-000 Beta McCoy\Risk Stuff\Wetlands	Variable:	Phenanthrene	

Raw Statistics	
Number of Valid Samples	122
Number of Unique Samples	64
Minimum	25
Maximum	2600
Mean	274.4139
Median	150
Standard Deviation	434.9922
Variance	189218.2
Coefficient of Variation	1.585168
Skewness	3.594295

Gamma Statistics	
k hat	1.045446
k star (bias corrected)	1.025203
Theta hat	262.485
Theta star	267.6679
nu hat	255.0889
nu star	250.1495
Approx.Chi Square Value (.05)	214.5229
Adjusted Level of Significance	0.048033
Adjusted Chi Square Value	214.1318

Log-transformed Statistics	
Minimum of log data	3.218876
Maximum of log data	7.863267
Mean of log data	5.065349
Standard Deviation of log data	0.922676
Variance of log data	0.851332

RECOMMENDATION
Data are Non-parametric (0.05)
Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.311662
Lilliefors 5% Critical Value	0.080215
Data not normal at 5% significance level	
95% UCL (Assuming Normal Distribution)	
Student's-t UCL	339.6919

Gamma Distribution Test	
A-D Test Statistic	7.582306
A-D 5% Critical Value	0.781982
K-S Test Statistic	0.197626
K-S 5% Critical Value	0.086196
Data do not follow gamma distribution at 5% significance level	
95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	319.9869
Adjusted Gamma UCL	320.5713

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.117132
Lilliefors 5% Critical Value	0.080215
Data not lognormal at 5% significance level	
95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	289.6588
95% Chebyshev (MVUE) UCL	344.6947
97.5% Chebyshev (MVUE) UCL	389.4287
99% Chebyshev (MVUE) UCL	477.2998

95% Non-parametric UCLs	
CLT UCL	339.1921
Adj-CLT UCL (Adjusted for skewness)	352.8857
Mod-t UCL (Adjusted for skewness)	341.8278
Jackknife UCL	339.6919
Standard Bootstrap UCL	340.8476
Bootstrap-t UCL	364.2026
Hall's Bootstrap UCL	353.5453
Percentile Bootstrap UCL	342.9959
BCA Bootstrap UCL	350.0738
95% Chebyshev (Mean, Sd) UCL	446.0776
97.5% Chebyshev (Mean, Sd) UCL	520.3566
99% Chebyshev (Mean, Sd) UCL	666.2633

Data File	J:\B345-000 Beta McCoy\Risk Stuff\Wetlands	Variable:	Pyrene

Raw Statistics	
Number of Valid Samples	122
Number of Unique Samples	69
Minimum	25
Maximum	5600
Mean	350.7172
Median	170
Standard Deviation	691.0707
Variance	477578.8
Coefficient of Variation	1.97045
Skewness	5.4638

Gamma Statistics	
k hat	0.93018
k star (bias corrected)	0.912771
Theta hat	377.0424
Theta star	384.2335
nu hat	226.9639
nu star	222.7161
Approx.Chi Square Value (.05)	189.1679
Adjusted Level of Significance	0.048033
Adjusted Chi Square Value	188.8014

Log-transformed Statistics	
Minimum of log data	3.218876
Maximum of log data	8.630522
Mean of log data	5.234038
Standard Deviation of log data	0.962164
Variance of log data	0.925759

RECOMMENDATION

Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.331381
Lilliefors 5% Critical Value	0.080215
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	454.4241

Gamma Distribution Test	
A-D Test Statistic	8.02026
A-D 5% Critical Value	0.786553
K-S Test Statistic	0.200448
K-S 5% Critical Value	0.0865
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	412.9156
Adjusted Gamma UCL	413.7172

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.098352
Lilliefors 5% Critical Value	0.080215
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	359.6613
95% Chebyshev (MVUE) UCL	430.2313
97.5% Chebyshev (MVUE) UCL	488.1767
99% Chebyshev (MVUE) UCL	601.999

95% Non-parametric UCLs	
CLT UCL	453.6301
Adj-CLT UCL (Adjusted for skewness)	486.7004
Mod-t UCL (Adjusted for skewness)	459.5824
Jackknife UCL	454.4241
Standard Bootstrap UCL	453.8195
Bootstrap-t UCL	534.6792
Hall's Bootstrap UCL	873.495
Percentile Bootstrap UCL	461.2582
BCA Bootstrap UCL	505.377
95% Chebyshev (Mean, Sd) UCL	623.4387
97.5% Chebyshev (Mean, Sd) UCL	741.4455
99% Chebyshev (Mean, Sd) UCL	973.2471

Data File	J:\B345-000 Beta McCoy\Risk Stuff\Wetlands	Variable:	Cadmium		

Raw Statistics	
Number of Valid Samples	123
Number of Unique Samples	89
Minimum	0.19
Maximum	5.75
Mean	1.054797
Median	0.79
Standard Deviation	0.916214
Variance	0.839448
Coefficient of Variation	0.868617
Skewness	2.686119

Gamma Statistics	
k hat	2.105922
k star (bias corrected)	2.059978
Theta hat	0.500872
Theta star	0.512043
nu hat	518.0569
nu star	506.7547
Approx.Chi Square Value (.05)	455.5405
Adjusted Level of Significance	0.048049
Adjusted Chi Square Value	454.9707

Log-transformed Statistics	
Minimum of log data	-1.660731
Maximum of log data	1.7492
Mean of log data	-0.202482
Standard Deviation of log data	0.692457
Variance of log data	0.479497

RECOMMENDATION

Data are lognormal (0.05)

Use H-UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.216269
Lilliefors 5% Critical Value	0.079888
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	1.191722

Gamma Distribution Test	
A-D Test Statistic	1.968531
A-D 5% Critical Value	0.764672
K-S Test Statistic	0.11545
K-S 5% Critical Value	0.084566
Data do not follow gamma distribution	
at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	1.173382
Adjusted Gamma UCL	1.174852

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.070481
Lilliefors 5% Critical Value	0.079888
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	1.172277
95% Chebyshev (MVUE) UCL	1.346756
97.5% Chebyshev (MVUE) UCL	1.481446
99% Chebyshev (MVUE) UCL	1.746018

95% Non-parametric UCLs	
CLT UCL	1.190682
Adj-CLT UCL (Adjusted for skewness)	1.212061
Mod-t UCL (Adjusted for skewness)	1.195056
Jackknife UCL	1.191722
Standard Bootstrap UCL	1.187447
Bootstrap-t UCL	1.232909
Hall's Bootstrap UCL	1.216191
Percentile Bootstrap UCL	1.192276
BCA Bootstrap UCL	1.22187
95% Chebyshev (Mean, Sd) UCL	1.414895
97.5% Chebyshev (Mean, Sd) UCL	1.57071
99% Chebyshev (Mean, Sd) UCL	1.876778

Data File	J:\B345-000 Beta McCoy\Risk Stuff\Wetlands	Variable:	Lead

Raw Statistics	
Number of Valid Samples	123
Number of Unique Samples	93
Minimum	1.7
Maximum	810
Mean	97.55805
Median	46
Standard Deviation	146.1268
Variance	21353.05
Coefficient of Variation	1.497845
Skewness	2.783457

Gamma Statistics	
k hat	0.734122
k star (bias corrected)	0.721637
Theta hat	132.8908
Theta star	135.19
nu hat	180.594
nu star	177.5226
Approx.Chi Square Value (.05)	147.7012
Adjusted Level of Significance	0.048049
Adjusted Chi Square Value	147.3811

Log-transformed Statistics	
Minimum of log data	0.530628
Maximum of log data	6.697034
Mean of log data	3.762625
Standard Deviation of log data	1.318884
Variance of log data	1.739456

RECOMMENDATION
Data are lognormal (0.05)
Use H-UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.255915
Lilliefors 5% Critical Value	0.079888
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	119.3962

Gamma Distribution Test	
A-D Test Statistic	2.445085
A-D 5% Critical Value	0.796806
K-S Test Statistic	0.107818
K-S 5% Critical Value	0.08689
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	117.2554
Adjusted Gamma UCL	117.51

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.049995
Lilliefors 5% Critical Value	0.079888
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	138.3066
95% Chebyshev (MVUE) UCL	171.1125
97.5% Chebyshev (MVUE) UCL	201.2634
99% Chebyshev (MVUE) UCL	260.489

95% Non-parametric UCLs	
CLT UCL	119.2303
Adj-CLT UCL (Adjusted for skewness)	122.7637
Mod-t UCL (Adjusted for skewness)	119.9473
Jackknife UCL	119.3962
Standard Bootstrap UCL	118.7295
Bootstrap-t UCL	123.1889
Hall's Bootstrap UCL	122.9418
Percentile Bootstrap UCL	119.912
BCA Bootstrap UCL	123.2833
95% Chebyshev (Mean, Sd) UCL	154.9901
97.5% Chebyshev (Mean, Sd) UCL	179.841
99% Chebyshev (Mean, Sd) UCL	228.6557

General Statistics

Data File	J:\B345-000 Beta McCoy\Risk Stuff\Wetlands	Variable:	Mercury

Raw Statistics	
Number of Valid Samples	123
Number of Unique Samples	99
Minimum	0.0055
Maximum	2.06
Mean	0.148659
Median	0.106
Standard Deviation	0.212161
Variance	0.045012
Coefficient of Variation	1.427167
Skewness	6.54453

Gamma Statistics	
k hat	1.285201
k star (bias corrected)	1.259275
Theta hat	0.115669
Theta star	0.118051
nu hat	316.1595
nu star	309.7816
Approx.Chi Square Value (.05)	269.9996
Adjusted Level of Significance	0.048049
Adjusted Chi Square Value	269.5633

Log-transformed Statistics	
Minimum of log data	-5.203007
Maximum of log data	0.722706
Mean of log data	-2.343128
Standard Deviation of log data	0.94172
Variance of log data	0.886837

RECOMMENDATION

Data are lognormal (0.05)

Use H-UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.249912
Lilliefors 5% Critical Value	0.079888
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	0.180365

Gamma Distribution Test	
A-D Test Statistic	1.772303
A-D 5% Critical Value	0.775742
K-S Test Statistic	0.096561
K-S 5% Critical Value	0.085475
Data do not follow gamma distribution	
at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	0.170562
Adjusted Gamma UCL	0.170838

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.079072
Lilliefors 5% Critical Value	0.079888
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	0.179466
95% Chebyshev (MVUE) UCL	0.21403
97.5% Chebyshev (MVUE) UCL	0.242237
99% Chebyshev (MVUE) UCL	0.297643

95% Non-parametric UCLs	
CLT UCL	0.180124
Adj-CLT UCL (Adjusted for skewness)	0.192186
Mod-t UCL (Adjusted for skewness)	0.182247
Jackknife UCL	0.180365
Standard Bootstrap UCL	0.179932
Bootstrap-t UCL	0.205917
Hall's Bootstrap UCL	0.319697
Percentile Bootstrap UCL	0.181663
BCA Bootstrap UCL	0.195232
95% Chebyshev (Mean, Sd) UCL	0.232044
97.5% Chebyshev (Mean, Sd) UCL	0.268125
99% Chebyshev (Mean, Sd) UCL	0.338998

Appendix D
Avian Risk Characterization Calculations

APPENDIX D
TABLE D-1
RISK CHARACTERIZATION CALCULATIONS
AMERICAN ROBIN
Former McCoy Field Wetland Area
New Bedford, Massachusetts

$Intake_{soil}$ =	**C_{soil} x IR_{soil} x $BA_{soil/food}$ x A/FA**
$Intake_{food}$ =	**$[(C_{food1} \times F_1) + (C_{food2} \times F_2)] \times IR_{food} \times BA_{soil/food} \times A/FA$**
$Intake_{water}$ =	**$C_{water} \times IR_{water} \times A/FA$**
$Intake_{total}$ =	**$Intake_{soil} + Intake_{food} + Intake_{water}$**
HI-Low =	**$Intake_{total}$/TRV-High**
HI-High =	**$Intake_{total}$/TRV-Low**

		Value		Source
HI-Low =	Low estimate of hazard index (unitless)	Calculated		--
HI-High =	High estimate of hazard index (unitless)	Calculated		--
TRV-Low =	Toxicity reference value (low (mg/kgBW-dy)	Constituent-specific		see applicable table.
TRV-High =	Toxicity reference value (low (mg/kgBW-dy)	Constituent-specific		see applicable table.
$Intake_{total}$ =	Total intake of constituent from all pathways (mg/kgBW-dy)	Calculated		--
$Intake_{soil}$ =	Intake of constituent from soil ingestion (mg/kgBW-dy)	Calculated		--
$Intake_{food}$ =	Intake of constituent from food ingestion (mg/kgBW-dy)	Calculated		--
$Intake_{water}$ =	Intake of constituent from water ingestion (mg/kgBW-dy)	Calculated		--
C_{soil} =	Soil constituent concentration (mg/kgDW)	Constituent-specific		--
IR_{soil} =	Soil ingestion rate (kgDW/kgBW-day)	0.0143		U.S. EPA (1999)
$BA_{soil/food}$ =	Bioavailability from soil/food (unitless)	Constituent-specific		
$C_{food\,i}$ =	Food constituent concentration in *ith* food type (mg/kg WW)	Constituent-specific		--
F_i =	Fraction of ith food type in diet (unitless)	0.38	invertebrates	U.S. EPA (1993)
		0.62	vegetation	U.S. EPA (1993)
IR_{food} =	Total food ingestion rate (kgWW/kgBW-day)	0.44		U.S. EPA (1999)
C_{water} =	Water constituent concentration (mg/L)	Constituent-specific		--
IR_{water} =	Water ingestion rate (L/kgBW-day)	0.137		U.S. EPA (1999)
A =	On-site foraging area (acres)	4	Site estimate	Estimated site wetland area.
FA =	Total foraging area for organism (acres)	1.2		U.S. EPA (1993)
$C_{food1\ (invert)}$ =	C_{soil} x BCF_{SSI}			
BCF_{SSI} =	Soil-to-soil invertebrate bioaccumulation factor [(mg/kg WW)/(mg/kg soil)]			
$C_{food2\ (veg)}$ =	C_{soil} x BCF_r x 0.12			
BCF_r =	Plant-soil biotransfer factor [(mg/kg DW)/(mg/kg soil)			
0.12 =	Dry weight (DW) to wet weight (WW) conversion factor (unitless)			
[A/FA]=	1 or less			

Constituent	C_{soil} (mg/kg DW)	$BA_{soil/food}$ (unitless)	IR_{soil} (kgDW/kgBW-dy)	BCF_{SSI} (mg/kg WW)/(mg/kg DW soil)	$C_{food(invert)}$ (mg/kg WW)	$F_{food(invert)}$ (unitless)	BCF_r (mg/kg DW)/(mg/kg DW soil)	0.12 (unitless)	$C_{food(veg)}$ (mg/kg WW)	$F_{food(veg)}$ (unitless)	IR_{food} (kgWW/kgBW-dy)	C_{water} (mg/L)	IR_{water} L/kgBW-day	A/FA (unitless)	$Intake_{soil}$ (mg/kgBW-dy)	$Intake_{food}$ (mg/kgBW-dy)	$Intake_{water}$ (mg/kgBW-dy)	$Intake_{total}$ (mg/kgBW-dy)	TRV-Low (mg/kgBW-dy)	HI- High (unitless)	TRV-High (mg/kgBW-dy)	HI-Low (unitless)
PCBs (as Aroclor 1254)	2.09	1	0.0143	1.13	2.36E+00	0.38	1.27E-02	0.12	3.18E-03	0.62	0.44	6.67E-07	0.137	1	2.99E-02	3.96E-01	9.14E-08	4.26E-01	0.09	5	1.8	0.2
Acenaphthene	0.191	1	0.0143	0.05	9.55E-03	0.38	2.10E-01	0.12	4.81E-03	0.62	0.44	2.56E-05	0.137	1	2.73E-03	2.91E-03	3.50E-06	5.64E-03	2	0.003	2	0.003
Anthracene	0.221	1	0.0143	0.05	1.11E-02	0.38	9.20E-02	0.12	2.44E-03	0.62	7	9.15E-06	0.137	1	3.16E-03	4.00E-02	1.25E-06	4.31E-02	1	0.04	1	0.04
Benzo(a)anthracene	0.401	1	0.0143	0.03	1.20E-02	0.38	1.43E-02	0.12	6.87E-04	0.62	0.44	1.25E-06	0.137	1	5.73E-03	2.20E-03	1.72E-07	7.93E-03	1.1	0.007	1.1	0.007
Benzo(b)fluoranthene	0.274	1	0.0143	0.07	1.92E-02	0.38	1.72E-02	0.12	5.66E-04	0.62	0.44	1.20E-06	0.137	1	3.92E-03	3.36E-03	1.64E-07	7.28E-03	2	0.004	2	0.004
Benzo(k)fluoranthene	0.218	1	0.0143	0.08	1.74E-02	0.38	1.32E-02	0.12	3.45E-04	0.62	0.44	5.74E-07	0.137	1	3.12E-03	3.01E-03	7.86E-08	6.13E-03	2	0.003	2	0.003
Benzo(g,h,i)perylene	0.213	1	0.0143	0.05	1.07E-02	0.38	6.78E-03	0.12	1.73E-04	0.62	0.44	2.18E-07	0.137	1	3.05E-03	1.83E-03	2.99E-08	4.87E-03	2	0.002	2	0.002
Benzo(a)pyrene	0.395	1	0.0143	0.07	2.77E-02	0.38	1.25E-02	0.12	5.92E-04	0.62	0.44	9.60E-07	0.137	1	5.65E-03	4.78E-03	1.32E-07	1.04E-02	2	0.005	2	0.005
Chrysene	0.377	1	0.0143	0.04	1.51E-02	0.38	2.60E-02	0.12	1.18E-03	0.62	0.44	1.47E-06	0.137	1	5.39E-03	2.84E-03	2.02E-07	8.23E-03	2	0.004	2	0.004
Fluoranthene	0.329	1	0.0143	0.05	1.65E-02	0.38	3.72E-02	0.12	1.47E-03	0.62	0.44	3.77E-06	0.137	1	4.70E-03	3.15E-03	5.16E-07	7.86E-03	2	0.004	2	0.004
Fluorene	0.203	1	0.0143	0.05	1.02E-02	0.38	1.49E-01	0.12	3.62E-03	0.62	0.44	1.66E-05	0.137	1	2.90E-03	2.68E-03	2.27E-06	5.59E-03	1	0.006	1	0.006
Indeno(1,2,3-cd)pyrene	0.208	1	0.0143	0.08	1.66E-02	0.38	3.48E-03	0.12	8.69E-05	0.62	0.44	8.28E-08	0.137	1	2.97E-03	2.81E-03	1.13E-08	5.78E-03	2	0.003	2	0.003
Phenanthrene	0.446	1	0.0143	0.05	2.23E-02	0.38	8.84E-02	0.12	4.73E-03	0.62	0.44	1.74E-05	0.137	1	6.38E-03	5.02E-03	2.39E-06	1.14E-02	1.1	0.01	1.1	0.01
Pyrene	0.623	1	0.0143	0.05	3.12E-02	0.38	3.93E-02	0.12	2.94E-03	0.62	0.44	7.72E-06	0.137	1	8.91E-03	6.01E-03	1.06E-06	1.49E-02	2	0.007	2	0.007
Barium	83	0.07	0.0143	0.01	8.30E-01	0.38	1.50E-01	0.12	1.49E+00	0.62	0.44	2.63E-02	0.137	1	8.31E-02	3.82E-02	3.60E-03	1.25E-01	20.8	0.006	47.1	0.003
Cadmium	1.17	0.01	0.0143	0.96	1.12E+00	0.38	3.64E-01	0.12	5.11E-02	0.62	0.44	5.86E-05	0.137	1	1.67E-04	2.02E-03	8.03E-06	2.19E-03	1.45	0.002	20	0.0001
Chromium	13	0.005	0.0143	0.01	1.30E-01	0.38	7.50E-03	0.12	1.17E-02	0.62	0.44	1.72E-05	0.137	1	9.30E-04	1.25E-04	2.36E-06	1.06E-03	1	0.001	5	0.0002
Lead	138	0.12	0.0143	0.03	4.14E+00	0.38	4.50E-02	0.12	7.45E-01	0.62	0.44	3.47E-04	0.137	1	2.37E-01	1.07E-01	4.75E-05	3.44E-01	1.13	0.3	11.3	0.03
Mercury	0.18	0.07	0.0143	0.04	7.20E-03	0.38	3.75E-02	0.12	8.10E-04	0.62	0.44	2.27E-06	0.137	1	1.80E-04	9.97E-05	3.10E-07	2.80E-04	0.039	0.007	0.9	0.0003
Selenium	0.92	0.44	0.0143	0.01	9.20E-03	0.38	1.60E-02	0.12	1.77E-03	0.62	0.44	2.31E-05	0.137	1	5.79E-03	8.89E-04	3.17E-06	6.68E-03	0.5	0.01	1.0	0.007
																			HI =	5	HI =	0.4

U.S. EPA (1999). Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities. EPA 530-D-99-001A, August.
U.S. EPA (1993). Wildlife Exposure Factors Handbook, Volume I. EPA/600/R-93/187a, December.

APPENDIX D
TABLE D-2
RISK CHARACTERIZATION CALCULATIONS
RED-TAILED HAWK
Former McCoy Field Wetland Area
New Bedford, Massachusetts

$Intake_{soil}$ = **C_{soil} x IR_{soil} x $BA_{soil/food}$ x A/FA**
$Intake_{food}$ = **[(C_{food} x F) x IR_{food} x $BA_{soil/food}$ x A/FA**
$Intake_{water}$ = **C_{water} x IR_{water} x A/FA**
$Intake_{total}$ = **$Intake_{soil}$ + $Intake_{food}$ + $Intake_{water}$**
HI-Low = **$Intake_{total}$/TRV-High**
HI-High = **$Intake_{total}$/TRV-Low**

		Value		Source
HI-Low =	Low estimate of hazard index (unitless)	Calculated		--
HI-High =	High estimate of hazard index (unitless)	Calculated		--
TRV-Low =	Toxicity reference value (low) (mg/kgBW-dy)	Constituent-specific		see applicable table.
TRV-High =	Toxicity reference value (high) (mg/kgBW-dy)	Constituent-specific		see applicable table.
$Intake_{total}$ =	Total intake of constituent from all pathways (mg/kgBW-dy)	Calculated		--
$Intake_{soil}$ =	Intake of constituent from soil ingestion (mg/kgBW-dy)	Calculated		--
$Intake_{food}$ =	Intake of constituent from food ingestion (mg/kgBW-dy)	Calculated		--
$Intake_{water}$ =	Intake of constituent from water ingestion (mg/kgBW-dy)	Calculated		--
C_{soil} =	Soil constituent concentration (mg/kgDW)	Constituent-specific		--
IR_{soil} =	Soil ingestion rate (kgDW/kgBW-day)	0.00995		U.S. EPA (1999)
$C_{food/}$ =	Food constituent concentration in *ith* food type (mg/kg WW)	Constituent-specific		--
$F_{/}$ =	Fraction of ith food type in diet (unitless)	1	small mammals	Assumed
IR_{food} =	Total food ingestion rate (kgWW/kgBW-day)	0.185		U.S. EPA (1993)
$BA_{soil/food}$ =	Bioavailability from soil/food (unitless)	Constituent-specific		see applicable table.
C_{water} =	Water constituent concentration (mg/L)	Constituent-specific		--
IR_{water} =	Water ingestion rate (L/kgBW-day)	0.057		U.S. EPA (1999)
A =	On-site foraging area (acres)	4		Site estimate
FA =	Total foraging area for organism (acres)	1,700		U.S. EPA (1993)

C_{food} = BA_{mammal} [(C_{soil} x BCF_{ssi} x $BA_{soil/food}$ x $IR_{food\text{-}shrew}$)+(C_{soil} x $BA_{soil/food}$ x $IR_{soil\text{-}shrew}$)+(C_{SW} x $IR_{SW\text{-}shrew}$)]

where:
BA_{mammal} = Mammal biotransfer factor (dy/kg)
$IR_{food\text{-}shrew}$ = Shrew consumption rate of worms (kg/dy)
$IR_{soil\text{-}shrew}$ = Shrew consumption rate of soil (kg/dy)
$IR_{SW\text{-}shrew}$ = Shrew consumption rate of surface water (L/dy)

[A/FA]= 1 or less

Constituent	C_{soil} (mg/kg)	$BA_{soil/food}$ (unitless)	IR_{soil} (kg/kgBW-dy)	BCF_{ssi} (mg/kg WW)/ (mg/kg dry soil)	BA_{mammal} (day/kg FW tissue)	$IR_{food\text{-}shrew}$ (kg/dy)	$IR_{soil\text{-}shrew}$ (kg/dy)	$IR_{SW\text{-}shrew}$ (L/dy)	C_{food} (mg/kg WW)	IR_{food} (kgWW/kgBW-dy)	F_{food} (kg/kgBW-dy)	C_{water} (mg/L)	IR_{water} (L/kgBW-day)	A/FA (unitless)	$Intake_{soil}$ (mg/kgBW-dy)	$Intake_{food}$ (mg/kgBW-dy)	$Intake_{water}$ (mg/kgBW-dy)	$Intake_{total}$ (mg/kgBW-dy)	TRV-Low (mg/kgBW-dy)	HI-High (unitless)	TRV-High (mg/kgBW-dy)	HI-Low (unitless)
PCBs (as Aroclor 1254)	2.09	1	0.00995	1.13	2.69E-02	0.0075	0.00022	0.0023	4.89E-04	0.185	1	6.67E-07	0.057	0.0024	4.89E-05	2.13E-07	8.94E-11	4.91E-05	0.09	0.0005	1.8	0.00003
Acenaphthene	0.191	1	0.00995	0.05	2.09E-04	0.0075	0.00022	0.0023	2.37E-08	0.185	1	2.56E-05	0.057	0.0024	4.47E-06	1.03E-11	3.43E-09	4.48E-06	2	0.000002	2	0.000002
Anthracene	0.221	1	0.00995	0.05	8.71E-04	0.0075	0.00022	0.0023	1.14E-07	0.185	1	9.15E-06	0.057	0.0024	5.17E-06	4.97E-11	1.23E-09	5.18E-06	1	0.000005	1	0.000005
Benzo(a)anthracene	0.401	1	0.00995	0.03	2.19E-02	0.0075	0.00022	0.0023	3.88E-06	0.185	1	1.25E-06	0.057	0.0024	9.39E-06	1.69E-09	1.68E-10	9.39E-06	1.1	0.000009	1.1	0.000009
Benzo(b)fluoranthene	0.274	1	0.00995	0.07	1.58E-02	0.0075	0.00022	0.0023	3.22E-06	0.185	1	1.20E-06	0.057	0.0024	6.41E-06	1.40E-09	1.60E-10	6.42E-06	2	0.000003	2	0.000003
Benzo(k)fluoranthene	0.218	1	0.00995	0.08	2.51E-02	0.0075	0.00022	0.0023	4.48E-06	0.185	1	5.74E-07	0.057	0.0024	5.10E-06	1.95E-09	7.70E-11	5.11E-06	2	0.000003	2	0.000003
Benzo(g,h,i)perylene	0.213	1	0.00995	0.05	7.94E-02	0.0075	0.00022	0.0023	1.00E-05	0.185	1	2.18E-07	0.057	0.0024	4.99E-06	4.36E-09	2.93E-11	4.99E-06	2	0.000002	2	0.000002
Benzo(a)pyrene	0.395	1	0.00995	0.07	2.75E-02	0.0075	0.00022	0.0023	8.08E-06	0.185	1	9.60E-07	0.057	0.0024	9.25E-06	3.52E-09	1.29E-10	9.25E-06	2	0.000005	2	0.000005
Chrysene	0.377	1	0.00995	0.04	7.76E-03	0.0075	0.00022	0.0023	1.51E-06	0.185	1	1.47E-06	0.057	0.0024	8.83E-06	6.59E-10	1.98E-10	8.83E-06	2	0.000004	2	0.000004
Fluoranthene	0.329	1	0.00995	0.05	4.17E-03	0.0075	0.00022	0.0023	8.13E-07	0.185	1	3.77E-06	0.057	0.0024	7.70E-06	3.54E-10	5.05E-10	7.70E-06	2	0.000004	2	0.000004
Fluorene	0.203	1	0.00995	0.05	3.80E-04	0.0075	0.00022	0.0023	4.57E-08	0.185	1	1.66E-05	0.057	0.0024	4.75E-06	1.99E-11	2.22E-09	4.75E-06	1	0.000005	1	0.000005
Indeno(1,2,3-cd)pyrene	0.208	1	0.00995	0.08	2.51E-01	0.0075	0.00022	0.0023	4.27E-05	0.185	1	8.28E-08	0.057	0.0024	4.87E-06	1.86E-08	1.11E-11	4.89E-06	2	0.000002	2	0.000002
Phenanthrene	0.446	1	0.00995	0.05	9.33E-04	0.0075	0.00022	0.0023	2.47E-07	0.185	1	1.74E-05	0.057	0.0024	1.04E-05	1.07E-10	2.34E-09	1.04E-05	1.1	0.000009	1.1	0.000009
Pyrene	0.623	1	0.00995	0.05	3.80E-03	0.0075	0.00022	0.0023	1.40E-06	0.185	1	7.72E-06	0.057	0.0024	1.46E-05	6.11E-10	1.04E-09	1.46E-05	2	0.000007	2	0.000007
Barium	83	0.07	0.00995	0.01	9.43E-03	0.0075	0.00022	0.0023	1.66E-05	0.185	1	2.63E-02	0.057	0.0024	1.36E-04	5.05E-10	3.52E-06	1.40E-04	20.8	0.000007	47.1	0.000003
Cadmium	1.17	0.01	0.00995	0.96	7.54E-03	0.0075	0.00022	0.0023	6.55E-07	0.185	1	5.86E-05	0.057	0.0024	2.74E-07	2.85E-12	7.87E-09	2.82E-07	1.45	0.0000002	20	0.00000001
Chromium	13	0.005	0.00995	0.01	3.45E-01	0.0075	0.00022	0.0023	6.57E-06	0.185	1	1.72E-05	0.057	0.0024	1.52E-06	1.43E-11	2.31E-09	1.52E-06	1	0.000002	5	0.0000003
Lead	138	0.12	0.00995	0.03	1.88E-02	0.0075	0.00022	0.0023	1.38E-04	0.185	1	3.47E-04	0.057	0.0024	3.88E-04	7.20E-09	4.65E-08	3.88E-04	1.13	0.0003	11.3	0.00003
Mercury	0.18	0.07	0.00995	0.04	3.26E-01	0.0075	0.00022	0.0023	2.13E-06	0.185	1	2.27E-06	0.057	0.0024	2.95E-07	6.49E-11	3.04E-10	2.95E-07	0.039	0.000008	0.9	0.0000003
Selenium	0.92	0.44	0.00995	0.01	1.43E-01	0.0075	0.00022	0.0023	1.69E-05	0.185	1	2.31E-05	0.057	0.0024	9.48E-06	3.23E-09	3.10E-09	9.48E-06	0.5	0.00002	1	0.000009
Total																			HI =	0.001	HI =	0.0001

U.S. EPA (1999). Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities. EPA 530-D-99-001A, August.
U.S. EPA (1993). Wildlife Exposure Factors Handbook, Volume I. EPA/600/R-93/187a, December.

APPENDIX D
TABLE D-3
CHEMICAL PROPERTIES AND INTERMEDIATE CALCULATIONS
AVIAN RECEPTORS
Former McCoy Field Wetland Area
New Bedford, Massachusetts

Constituent	Soil/Sediment Concentration C_{soil} (mg/kg)	Estimated Surface Water Concentration C_{SW} (mg/L)	Bioavailability from Soil [1] BA_{soil} (unitless)	n-Octanol/Water Partition Coefficient K_{ow} (L/kg)	Sediment/Water Partition Coefficient [2] K_D (L/kg)	Soil-to-Soil Invertebrate Bioconcentration Factor BCF_{SSI} (mg/kg WW)/ (mg/kg DW soil)	Soil-to-Plant Bioconcentration Factor BCF_r (mg/kg DW)/ (mg/kg DW soil)	Mammal Biotransfer Factor BA_{mammal} (day/kg WW tissue)	Shrew Food Ingestion Rate [3] $IR_{food\text{-}shrew}$ (kg/dy)	Shrew Soil Ingestion Rate [3] $IR_{soil\text{-}shrew}$ (kg/dy)	Shrew Surface Water Ingestion Rate [3] $IR_{SW\text{-}shrew}$ (L/dy)
PCBs (as Aroclor 1254)	2.09	6.67E-07	1	1.07E+06 [7]	--	1.13E+00 [9]	1.27E-02 [11]	2.69E-02 [4]	0.0075	0.00022	0.0023
Acenaphthene	0.191	2.56E-05	1	8.32E+03 [8]	--	5.00E-02 [10]	2.10E-01 [11]	2.09E-04 [4]	0.0075	0.00022	0.0023
Anthracene	0.221	9.15E-06	1	3.47E+04 [8]	--	5.00E-02 [10]	9.20E-02 [11]	8.71E-04 [4]	0.0075	0.00022	0.0023
Benzo(a)anthracene	0.401	1.25E-06	1	8.71E+05 [8]	--	3.00E-02 [9]	1.43E-02 [11]	2.19E-02 [4]	0.0075	0.00022	0.0023
Benzo(b)fluoranthene	0.274	1.20E-06	1	6.31E+05 [8]	--	7.00E-02 [9]	1.72E-02 [11]	1.58E-02 [4]	0.0075	0.00022	0.0023
Benzo(k)fluoranthene	0.218	5.74E-07	1	1.00E+06 [8]	--	8.00E-02 [9]	1.32E-02 [11]	2.51E-02 [4]	0.0075	0.00022	0.0023
Benzo(g,h,i)perylene	0.213	2.18E-07	1	3.16E+06 [8]	--	5.00E-02 [10]	6.78E-03 [11]	7.94E-02 [4]	0.0075	0.00022	0.0023
Benzo(a)pyrene	0.395	9.60E-07	1	1.10E+06 [8]	--	7.00E-02 [9]	1.25E-02 [11]	2.75E-02 [4]	0.0075	0.00022	0.0023
Chrysene	0.377	1.47E-06	1	3.09E+05 [8]	--	4.00E-02 [9]	2.60E-02 [11]	7.76E-03 [4]	0.0075	0.00022	0.0023
Fluoranthene	0.329	3.77E-06	1	1.66E+05 [8]	--	5.00E-02 [10]	3.72E-02 [11]	4.17E-03 [4]	0.0075	0.00022	0.0023
Fluorene	0.203	1.66E-05	1	1.51E+04 [8]	--	5.00E-02 [10]	1.49E-01 [11]	3.80E-04 [4]	0.0075	0.00022	0.0023
Indeno(1,2,3-cd)pyrene	0.208	8.28E-08	1	1.00E+07 [8]	--	8.00E-02 [9]	3.48E-03 [11]	2.51E-01 [4]	0.0075	0.00022	0.0023
Phenanthrene	0.446	1.74E-05	1	3.72E+04 [8]	--	5.00E-02 [10]	8.84E-02 [11]	9.33E-04 [4]	0.0075	0.00022	0.0023
Pyrene	0.623	7.72E-06	1	1.51E+05 [8]	--	5.00E-02 [10]	3.93E-02 [11]	3.80E-03 [4]	0.0075	0.00022	0.0023
Barium	83	2.63E-02	0.07	-	3.16E+02	1.00E-02 [5]	1.50E-01 [9]	9.43E-03 [12]	0.0075	0.00022	0.0023
Cadmium	1.17	5.86E-05	0.01	-	2.00E+03	9.60E-01 [9]	3.64E-01 [9]	7.54E-03 [12]	0.0075	0.00022	0.0023
Chromium	13	1.72E-05	0.005	-	7.54E+04	1.00E-02 [9]	7.50E-03 [9]	3.45E-01 [12]	0.0075	0.00022	0.0023
Lead	138	3.47E-04	0.15	-	3.98E+04	3.00E-02 [9]	4.50E-02 [9]	1.88E-02 [12]	0.0075	0.00022	0.0023
Mercury	0.18	2.27E-06	0.07	-	7.94E+03	4.00E-02 [6,9]	3.75E-02 [6,9]	3.26E-01 [12]	0.0075	0.00022	0.0023
Selenium	0.92	2.31E-05	0.44	-	3.98E+03	1.00E-02 [5]	1.60E-02 [9]	1.43E-01 [12]	0.0075	0.00022	0.0023

mg = milligrams.
kg = kilograms.
L = liters.
dy = day
DW = dry weight.
WW = wet (fresh) weight.

1. Assumed value for organics; see associated table for metal references.
2. U.S. EPA (1999a) Partition Coefficients for Metals in Surface Water, Soil, and Waste (draft). June 22.
4. For organic constituents, log BA_{mammal} = -7.6 + log K_{ow}. (U.S. EPA 1999)
3. Calculated as 0.5 kg/kgBW-dy x 0.015 kg body weight (for food); 0.0145 kg/kgBW-dy x 0.015 kg (for soil); 0.151 L/kgW-dy x 0.015 kg (for surface water) (U.S. EPA 1999).
5. Reportedly does not bioaccumulate; lowest value of assessed metals applied [U.S. EPA (2005b) http://www.epa.gov/region5/superfund/ecology/html/toxprofiles.htm].
6. Value for mercuric chloride applied.
7. U.S. EPA (2004a). Water9 Version 2.0.0 Database.
8. TPHCWG (1998). Composition of Petroleum Mixtures. May.
9. U.S. EPA (1999). Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities. EPA 530-D-99-001A, August.
10. No value available; midpoint of available values for PAHs applied.
11. Calculated from the following regression equation: log BCF = 1.588 - 0.578 x Log K_{ow} per U.S. EPA (1999).
12. For metals, BA_{mammal} values were back-calculated from BCF values presented in U.S. EPA (1999) Table D-3 for short-tailed shrew, using a soil ingestion rate of 0.0145 kg/kg-dy and a body weight of 0.015 kg.

Appendix E
Mammalian Risk Characterization Calculations

APPENDIX E
TABLE E-1
RISK CHARACTERIZATION CALCULATIONS
SHORT-TAILED SHREW
Former McCoy Field Wetland Area
New Bedford, Massachusetts

$Intake_{soil}$ = $C_{soil} \times IR_{soil} \times BA_{soil/food} \times A/FA$
$Intake_{food}$ = $[(C_{food1} \times F_1) + (C_{food2} \times F_2)] \times IR_{food} \times BA_{soil/food} \times A/FA$
$Intake_{water}$ = $C_{water} \times IR_{water} \times A/FA$
$Intake_{total}$ = $Intake_{soil} + Intake_{food} + Intake_{water}$
HI-High = $Intake_{total}/TRV\text{-}Low$
HI-Low = $Intake_{total}/TRV\text{-}High$

			Value		Source
HI-High =	High estimate of hazard index (unitless)		Calculated		--
HI-Low =	Low estimate of hazard index (unitless)		Calculated		--
TRV-Low =	Toxicity Reference Value - Low (mg/kgBW-dy)		Constituent-specific		See associated table
TRV-High =	Toxicity Reference Value - High (mg/kgBW-dy)		Constituent-specific		See associated table
$Intake_{total}$ =	Total intake of constituent from all pathways (mg/kgBW-dy)		Calculated		--
$Intake_{soil}$ =	Intake of constituent from soil ingestion (mg/kgBW-dy)		Calculated		--
$Intake_{food}$ =	Intake of constituent from food ingestion (mg/kgBW-dy)		Calculated		--
$Intake_{water}$ =	Intake of constituent from water ingestion (mg/kgBW-dy)		Calculated		--
C_{soil} =	Soil constituent concentration (mg/kgDW)		Constituent-specific		--
IR_{soil} =	Soil ingestion rate (kgDW/kgBW-day)		0.0145		Assuming 10% of food intake and a 71% food moisture content (68% for invertebrates; 88% for vegetation).
$BA_{soil/food}$ =	Bioavailability from soil and food (unitless)		Constituent-specific		See associated table
C_{food} =	Food constituent concentration in *ith* food type (mg/kgWW)		Constituent-specific		--
$F_{food/}$	Fraction of diet for *ith* food (unitless)	F_{food1} =	0.83	invertebrates	U.S. EPA (1993)
		F_{food2} =	0.17	vegetation	U.S. EPA (1993)
IR_{food} =	Total food ingestion rate (kgWW/kgBW-day)		0.5		U.S. EPA (1993)
C_{water} =	Water constituent concentration (mg/L)		Constituent-specific		--
IR_{water} =	Water ingestion rate (L/kgBW-day)		0.151		U.S. EPA (1999)
A =	On-site foraging area (acres)		4		Site estimate
FA =	Total foraging area for organism (acres)		0.9		U.S. EPA (1993)

$C_{food\ (invertebrates)}$ = = $C_{soil} \times BCF_{ssi}$

BCF_{ssi} = Soil-to-soil invertebrate bioaccumulation factor [(mg/kg WW)/(mg/kgDW soil)]

$C_{food\ (vegetation)}$ = $C_{soil} \times BCF_r \times 0.12$
where: BCF_r = Plant-soil bioconcentration factor [(mg/kgDW)/(mg/kgDW soil)
0.12 = Dry weight (DW) to wet weight (WW) conversion factor (unitless) (assumed vegetation is 88% moisture).

[A/FA]= 1 or less

Constituent	C_{soil} (mg/kg)	$BA_{soil/food}$ (unitless)	IR_{soil} (kg/kgBW-dy)	Soil-to-Soil Invertebrate BCF_{ssi} (mg/kg WW)/ (mg/kg DW soil)	$C_{food(invert)}$ (mg/kg WW)	$F_{food(inverts)}$ (kg/kgBW-dy)	BCF_r (mg/kg WW)/ (mg/kg DW soil)	0.12 (unitless)	$C_{food(veg)}$ (mg/kg WW)	$F_{food(veg)}$ (kg/kgBW-dy)	IR_{food} (kg/kgBW-dy)	C_{water} (mg/L)	IR_{water} (L/kgBW-day)	A/FA (unitless)	$Intake_{soil}$ (mg/kgBW-dy)	$Intake_{food}$ (mg/kgBW-dy)	$Intake_{water}$ (mg/kgBW-dy)	$Intake_{total}$ (mg/kgBW-dy)	TRV-Low (mg/kgBW-dy)	HI-High (unitless)	TRV-High (mg/kgBW-dy)	HI-Low (unitless)
PCBs (as Aroclor 1254)	2.09	1	0.0145	1.13	2.36E+00	0.83	1.27E-02	0.12	2.20E-05	0.17	0.5	6.67E-07	0.151	1	3.03E-02	9.80E-01	1.01E-07	1.01E+00	0.36	3	1.28	0.8
Acenaphthene	0.191	1	0.0145	0.05	9.55E-03	0.83	2.10E-01	0.12	3.65E-04	0.17	0.5	2.56E-05	0.151	1	2.77E-03	3.99E-03	3.86E-06	6.77E-03	17.5	0.0004	17.5	0.0004
Anthracene	0.221	1	0.0145	0.05	1.11E-02	0.83	9.20E-02	0.12	1.60E-04	0.17	0.5	9.15E-06	0.151	1	3.20E-03	4.60E-03	1.38E-06	7.81E-03	100	0.00008	100	0.00008
Benzo(a)anthracene	0.401	1	0.0145	0.03	1.20E-02	0.83	1.43E-02	0.12	2.48E-05	0.17	0.5	1.25E-06	0.151	1	5.81E-03	4.99E-03	1.89E-07	1.08E-02	0.167	0.06	0.167	0.06
Benzo(b)fluoranthene	0.274	1	0.0145	0.07	1.92E-02	0.83	1.72E-02	0.12	2.99E-05	0.17	0.5	1.20E-06	0.151	1	3.97E-03	7.96E-03	1.80E-07	1.19E-02	4	0.003	4	0.003
Benzo(k)fluoranthene	0.218	1	0.0145	0.08	1.74E-02	0.83	1.32E-02	0.12	2.29E-05	0.17	0.5	5.74E-07	0.151	1	3.16E-03	7.24E-03	8.66E-08	1.04E-02	7.2	0.001	7.2	0.001
Benzo(g,h,i)perylene	0.213	1	0.0145	0.05	1.07E-02	0.83	6.78E-03	0.12	1.18E-05	0.17	0.5	2.18E-07	0.151	1	3.09E-03	4.42E-03	3.29E-08	7.51E-03	7.2	0.001	7.2	0.001
Benzo(a)pyrene	0.395	1	0.0145	0.07	2.77E-02	0.83	1.25E-02	0.12	2.17E-05	0.17	0.5	9.60E-07	0.151	1	5.73E-03	1.15E-02	1.45E-07	1.72E-02	1.31	0.01	32.8	0.0005
Chrysene	0.377	1	0.0145	0.04	1.51E-02	0.83	2.60E-02	0.12	4.52E-05	0.17	0.5	1.47E-06	0.151	1	5.47E-03	6.26E-03	2.23E-07	1.17E-02	0.17	0.07	0.17	0.07
Fluoranthene	0.329	1	0.0145	0.05	1.65E-02	0.83	3.72E-02	0.12	6.48E-05	0.17	0.5	3.77E-06	0.151	1	4.77E-03	6.83E-03	5.69E-07	1.16E-02	12.5	0.0009	12.5	0.0009
Fluorene	0.203	1	0.0145	0.05	1.02E-02	0.83	1.49E-01	0.12	2.59E-04	0.17	0.5	1.66E-05	0.151	1	2.94E-03	4.23E-03	2.50E-06	7.18E-03	12.5	0.0006	12.5	0.0006
Indeno(1,2,3-cd)pyrene	0.208	1	0.0145	0.08	1.66E-02	0.83	3.48E-03	0.12	6.06E-06	0.17	0.5	8.28E-08	0.151	1	3.02E-03	6.91E-03	1.25E-08	9.92E-03	7.2	0.001	7.2	0.001
Phenanthrene	0.446	1	0.0145	0.05	2.23E-02	0.83	8.84E-02	0.12	1.54E-04	0.17	0.5	1.74E-05	0.151	1	6.47E-03	9.27E-03	2.63E-06	1.57E-02	100	0.0002	100	0.0002
Pyrene	0.623	1	0.0145	0.05	3.12E-02	0.83	3.93E-02	0.12	6.83E-05	0.17	0.5	7.72E-06	0.151	1	9.03E-03	1.29E-02	1.17E-06	2.20E-02	7.5	0.003	7.5	0.003
Barium	83	0.07	0.0145	0.01	8.30E-01	0.83	1.50E-01	0.12	2.61E-04	0.17	0.5	2.63E-02	0.151	1	8.42E-02	2.41E-02	3.97E-03	1.12E-01	2.8	0.04	10.5	0.01
Cadmium	1.17	0.01	0.0145	0.96	1.12E+00	0.83	3.64E-01	0.12	6.33E-04	0.17	0.5	5.86E-05	0.151	1	1.70E-04	4.66E-03	8.86E-06	4.84E-03	0.51	0.009	5.1	0.0009
Chromium	13	0.005	0.0145	0.01	1.30E-01	0.83	7.50E-03	0.12	1.31E-05	0.17	0.5	1.72E-05	0.151	1	9.43E-04	2.70E-04	2.60E-06	1.21E-03	2.4	0.0005	2.4	0.0005
Lead	138	0.12	0.0145	0.03	4.14E+00	0.83	4.50E-02	0.12	7.83E-05	0.17	0.5	3.47E-04	0.151	1	2.40E-01	2.06E-01	5.23E-05	4.46E-01	4.22	0.1	241	0.002
Mercury	0.18	0.07	0.0145	0.04	7.20E-03	0.83	3.75E-02	0.12	6.53E-05	0.17	0.5	2.27E-06	0.151	1	1.83E-04	2.10E-04	3.42E-07	3.93E-04	0.69	0.0006	4	0.0001
Selenium	0.92	0.44	0.0145	0.01	9.20E-03	0.83	1.60E-02	0.12	2.78E-05	0.17	0.5	2.31E-05	0.151	1	5.87E-03	1.68E-03	3.49E-06	7.55E-03	0.076	0.1	1.2	0.006
																			HI =	**3**	**HI =**	**1**

U.S. EPA (1999). Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities. EPA 530-D-99-001A, August.
U.S. EPA (1993). Wildlife Exposure Factors Handbook, Volume I. EPA/600/R-93/187a, December.

APPENDIX E
TABLE E-2
RISK CHARACTERIZATION CALCULATIONS
RACCOON
Former McCoy Field Wetland Area
New Bedford, Massachusetts

$Intake_{soil}$ = $C_{soil} \times IR_{soil} \times BA_{soil/food} \times A/FA$
$Intake_{food}$ = $[(C_{food1} \times F_1) + (C_{food2} \times F_2) + (C_{food3} \times F_3)] \times IR_{food} \times BA_{soil/food} \times A/FA$
$Intake_{water}$ = $C_{water} \times IR_{water} \times A/FA$
$Intake_{total}$ = $Intake_{soil} + Intake_{food} + Intake_{water}$
HI-High = $Intake_{total}/TRV\text{-}Low$
HI-Low = $Intake_{total}/TRV\text{-}High$

		Value		Source
HI-High =	High estimate of hazard index (unitless)	Calculated		--
HI-Low =	Low estimate of hazard index (unitless)	Calculated		--
TRV-Low =	Toxicity Reference Value - low (mg/kgBW-dy)	Constituent-specific		See associated table
TRV-High =	Toxicity Reference Value - High (mg/kgBW-dy)	Constituent-specific		See associated table
$Intake_{total}$ =	Total intake of constituent from all pathways (mg/kgBW-dy)	Calculated		--
$Intake_{food}$ =	Intake of constituent from food ingestion (mg/kgBW-dy)	Calculated		--
$Intake_{water}$ =	Intake of constituent from water ingestion (mg/kgBW-dy)	Calculated		--
C_{soil} =	Soil constituent concentration (mg/kgDW)	Constituent-specific		--
IR_{soil} =	Soil ingestion rate (kgDW/kgBW-day)	0.0058		Assume 10% of food ingestion rate; 80% food moisture (68% for invertebrates and mammals; 88% for vegetation).
$BA_{soil/food}$ =	Bioavailability from soil and food (unitless)	Constituent-specific		See associated table
$C_{food/}$ =	Constituent concentration in *ith* food (mg/kg WW)	Calculated		-
$F_{food/}$	Fraction of diet for *ith* food (unitless) F_{food1} =	0.58	vegetation	U.S. EPA (1993)
	F_{food2} =	0.17	invertebrates	U.S. EPA (1993)
	F_{food3} =	0.25	mammals	U.S. EPA (1993)
$IR_{food/}$ =	Total food ingestion rate (kgWW/kgBW-day)	0.29		Calculated as IR = 0.0687 (weight)$^{0.822}$, at a 5.8 kg body weight.
C_{water} =	Water constituent concentration (mg/L)	Constituent-specific		--
IR_{water} =	Water ingestion rate (L/kgBW-day)	0.08		U.S. EPA (1993)
A =	On-site foraging area (acres)	4		Site estimate
FA =	Total foraging area for organism (acres)	390		U.S. EPA (1993)

$C_{food\ (veg)}$ = $C_{soil} \times BCF_r \times 0.12$
where:
BCF_r = Plant-soil bioconcentration factor [(mg/kg DW)/(mg/kg soil)]
0.12 = Dry weight (DW) to wet weight (WW) conversion factor (unitless)

$C_{food\ (invert)}$ = $C_{soil} \times BCF_{ssl}$
where:
BCF = Soil to soil invertebrate bioaccumulation factor [(mg/kg WW)/(mg/kg soil)]

$C_{food\ (mammal)}$ = $BA_{mammal}\ [(C_{invert} \times BA_{soil/plant} \times IR_{food\text{-}shrew}) + (C_{soil} \times BA_{soil/food} \times IR_{soil\text{-}shrew}) + (C_{SW} \times IR_{SW\text{-}shrew})]$
where:
BA_{mammal} = Mammal biotransfer factor (dy/kg)
$IR_{food\text{-}shrew}$ = Shrew consumption rate of food (kg/dy)
$IR_{soil\text{-}shrew}$ = Shrew consumption rate of soil (kg/dy)
$IR_{SW\text{-}shrew}$ = Shrew consumption rate of surface water (L/dy)

[A/FA]= 1 or less

Constituent	C_{soil} (mg/kg)	$BA_{soil/food}$ (unitless)	IR_{soil} (kg/kgBW-dy)	BCF_r (mg/kg FW)/(mg/kg DW soil)	0.12 (unitless)	$C_{food(veg)}$ (mg/kg WW)	$F_{food(veg)}$ (kg/kgBW-dy)	BCF_{SSI} (mg/kgWW)/(mg/kgDW soil)	$C_{food\ (invert)}$ (mg/kgWW)	$F_{food(invert)}$ (kg/kgBW-dy)	BA_{mammal} (day/kgWW tissue)	$IR_{food\text{-}shrew}$ (kg/dy)	$IR_{soil\text{-}shrew}$ (kg/dy)	$IR_{SW\text{-}shrew}$ (L/dy)	$C_{food\ (mammal)}$ (mg/kgWW)	$F_{food(mammal)}$ (kg/kgBW-dy)	IR_{food} (kg/kgBW-dy)	C_{SW} (mg/L)	IR_{water} (L/kgBW-day)	A/FA (unitless)	$Intake_{soil}$ (mg/kgBW-dy)	$Intake_{food}$ (mg/kgBW-dy)	$Intake_{water}$ (mg/kgBW-dy)	$Intake_{total}$ (mg/kgBW-dy)	TRV-Low (mg/kgBW-dy)	HI-High (unitless)	TRV-High (mg/kgBW-dy)	HI-Low (unitless)
PCBs (as Aroclor 1254)	2.09	1	0.0058	1.27E-02	0.12	3.18E-03	0.58	1.13	2.36E+00	0.17	2.69E-02	0.0075	0.0002	0.0023	4.89E-04	0.25	0.29	6.67E-07	0.08	0.010	1.25E-04	1.21E-03	5.47E-10	1.33E-03	0.36	0.004	1.28	0.001
Acenaphthene	0.191	1	0.0058	2.10E-01	0.12	4.81E-03	0.58	0.05	9.55E-03	0.17	2.09E-04	0.0075	0.0002	0.0023	2.37E-08	0.25	0.29	2.56E-05	0.08	0.010	1.14E-05	1.32E-05	2.10E-08	2.46E-05	17.5	0.000001	17.5	0.000001
Anthracene	0.221	1	0.0058	9.20E-02	0.12	2.44E-03	0.58	0.05	1.11E-02	0.17	8.71E-04	0.0075	0.0002	0.0023	1.14E-07	0.25	0.29	9.15E-06	0.08	0.010	1.32E-05	9.84E-06	7.51E-09	2.31E-05	100	0.0000002	100	0.0000002
Benzo(a)anthracene	0.401	1	0.0058	1.43E-02	0.12	6.87E-04	0.58	0.03	1.20E-02	0.17	2.19E-02	0.0075	0.0002	0.0023	3.88E-06	0.25	0.29	1.25E-06	0.08	0.010	2.40E-05	7.31E-06	1.03E-09	3.13E-05	0.167	0.0002	0.167	0.0002
Benzo(b)fluoranthene	0.274	1	0.0058	1.72E-02	0.12	5.66E-04	0.58	0.07	1.92E-02	0.17	1.58E-02	0.0075	0.0002	0.0023	3.22E-06	0.25	0.29	1.20E-06	0.08	0.010	1.64E-05	1.07E-05	9.81E-10	2.71E-05	4	0.000007	4	0.000007
Benzo(k)fluoranthene	0.218	1	0.0058	1.32E-02	0.12	3.45E-04	0.58	0.08	1.74E-02	0.17	2.51E-02	0.0075	0.0002	0.0023	4.48E-06	0.25	0.29	5.74E-07	0.08	0.010	1.30E-05	9.46E-06	4.71E-10	2.25E-05	7.2	0.000003	7.2	0.000003
Benzo(g,h,i)perylene	0.213	1	0.0058	6.78E-03	0.12	1.73E-04	0.58	0.05	1.07E-02	0.17	7.94E-02	0.0075	0.0002	0.0023	1.00E-05	0.25	0.29	2.18E-07	0.08	0.010	1.27E-05	5.72E-06	1.79E-10	1.85E-05	7.2	0.000003	7.2	0.000003
Benzo(a)pyrene	0.395	1	0.0058	1.25E-02	0.12	5.92E-04	0.58	0.07	2.77E-02	0.17	2.75E-02	0.0075	0.0002	0.0023	8.08E-06	0.25	0.29	9.60E-07	0.08	0.010	2.36E-05	1.51E-05	7.88E-10	3.87E-05	1.31	0.00003	32.8	0.000001
Chrysene	0.377	1	0.0058	2.60E-02	0.12	1.18E-03	0.58	0.04	1.51E-02	0.17	7.76E-03	0.0075	0.0002	0.0023	1.51E-06	0.25	0.29	1.47E-06	0.08	0.010	2.25E-05	9.70E-06	1.21E-09	3.22E-05	0.17	0.0002	0.17	0.0002
Fluoranthene	0.329	1	0.0058	3.72E-02	0.12	1.47E-03	0.58	0.05	1.65E-02	0.17	4.17E-03	0.0075	0.0002	0.0023	8.13E-07	0.25	0.29	3.77E-06	0.08	0.010	1.97E-05	1.09E-05	3.09E-09	3.06E-05	12.5	0.000002	12.5	0.000002
Fluorene	0.203	1	0.0058	1.49E-01	0.12	3.62E-03	0.58	0.05	1.02E-02	0.17	3.80E-04	0.0075	0.0002	0.0023	4.57E-08	0.25	0.29	1.66E-05	0.08	0.010	1.21E-05	1.14E-05	1.36E-08	2.36E-05	12.5	0.000002	12.5	0.000002
Indeno(1,2,3-cd)pyrene	0.208	1	0.0058	3.48E-03	0.12	8.69E-05	0.58	0.08	1.66E-02	0.17	2.51E-01	0.0075	0.0002	0.0023	4.27E-05	0.25	0.29	8.28E-08	0.08	0.010	1.24E-05	8.64E-06	6.79E-11	2.11E-05	7.2	0.000003	7.2	0.000003
Phenanthrene	0.446	1	0.0058	8.84E-02	0.12	4.73E-03	0.58	0.05	2.23E-02	0.17	9.33E-04	0.0075	0.0002	0.0023	2.47E-07	0.25	0.29	1.74E-05	0.08	0.010	2.67E-05	1.95E-05	1.43E-08	4.62E-05	100	0.0000005	100	0.0000005
Pyrene	0.623	1	0.0058	3.93E-02	0.12	2.94E-03	0.58	0.05	3.12E-02	0.17	3.80E-03	0.0075	0.0002	0.0023	1.40E-06	0.25	0.29	7.72E-06	0.08	0.010	3.72E-05	2.09E-05	6.33E-09	5.82E-05	7.5	0.000008	7.5	0.000008
Barium	83	0.07	0.0058	1.50E-01	0.12	1.49E+00	0.58	0.01	8.30E-01	0.17	9.43E-03	0.0075	0.0002	0.0023	1.66E-05	0.25	0.29	2.63E-02	0.08	0.010	3.47E-04	2.11E-04	2.16E-05	5.80E-04	2.8	0.0002	10.5	0.00006
Cadmium	1.17	0.01	0.0058	3.64E-01	0.12	5.11E-02	0.58	0.96	1.12E+00	0.17	7.54E-03	0.0075	0.0002	0.0023	6.55E-07	0.25	0.29	5.86E-05	0.08	0.010	6.99E-07	6.59E-06	4.81E-08	7.34E-06	0.19	0.00004	5.1	0.000001
Chromium (total)	13	0.005	0.0058	7.50E-03	0.12	1.17E-02	0.58	0.01	1.30E-01	0.17	3.45E-01	0.0075	0.0002	0.0023	6.57E-06	0.25	0.29	1.72E-05	0.08	0.010	3.89E-06	4.32E-07	1.41E-08	4.33E-06	2.4	0.000002	2.4	0.000002
Lead	138	0.12	0.0058	4.50E-02	0.12	7.45E-01	0.58	0.03	4.14E+00	0.17	1.88E-02	0.0075	0.0002	0.0023	1.38E-04	0.25	0.29	3.47E-04	0.08	0.010	9.90E-04	4.07E-04	2.84E-07	1.40E-03	4.22	0.0003	241	0.000006
Mercury	0.18	0.07	0.0058	3.75E-02	0.12	8.10E-04	0.58	0.04	7.20E-03	0.17	3.26E-01	0.0075	0.0002	0.0023	2.13E-06	0.25	0.29	2.27E-06	0.08	0.010	7.53E-07	3.54E-07	1.86E-09	1.11E-06	0.69	0.000002	4	0.0000003
Selenium	0.92	0.44	0.0058	1.60E-02	0.12	1.77E-03	0.58	0.01	9.20E-03	0.17	1.43E-01	0.0075	0.0002	0.0023	1.69E-05	0.25	0.29	2.31E-05	0.08	0.010	2.42E-05	3.41E-05	1.90E-08	2.76E-05	0.076	0.0004	1.21	0.00002
																									HI =	**0.005**	**HI =**	**0.002**

U.S. EPA (1999). Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities. EPA 530-D-99-001A, August.
U.S. EPA (1993). Wildlife Exposure Factors Handbook, Volume I. EPA/600/R-93/187a, December.

APPENDIX E
TABLE E-3
CHEMICAL PROPERTIES AND INTERMEDIATE CALCULATIONS
MAMMALIAN RECEPTORS
Former McCoy Field Wetland Area
New Bedford, Massachusetts

Constituent	Soil/Sediment Concentration C_{soil} (mg/kg)	Estimated Surface Water Concentration C_{SW} (mg/L)	Bioavailability from Soil and Food[1] $BA_{soil/food}$ (unitless)	n-Octanol/Water Partition Coefficient K_{ow} (L/kg)	Sediment/Water Partition Coefficient[2] K_D (L/kg)	Soil-to-Soil Invertebrate Bioconcentration Factor BCF_{SSI} (mg/kg WW)/(mg/kg DWsoil)	Soil-to-Plant Bioconcentration Factor BCF_r (mg/kg DW)/(mg/kg DWsoil)	Mammal Biotransfer Factor BA_{mammal} (day/kg FW tissue)	Shrew Food Ingestion Rate[3] $IR_{food\text{-}shrew}$ (kg/dy)	Shrew Soil Ingestion Rate[3] $IR_{soil\text{-}shrew}$ (kg/dy)	Shrew Surface Water Ingestion Rate[3] $IR_{SW\text{-}shrew}$ (L/dy)
PCBs (as Aroclor 1254)	2.09	6.67E-07	1	1.07E+06 [7]	--	1.13E+00 [9]	1.27E-02 [11]	2.69E-02 [4]	0.0075	0.00022	0.0023
Acenaphthene	0.191	2.56E-05	1	8.32E+03 [8]	--	5.00E-02 [10]	2.10E-01 [11]	2.09E-04 [4]	0.0075	0.00022	0.0023
Anthracene	0.221	9.15E-06	1	3.47E+04 [8]	--	5.00E-02 [10]	9.20E-02 [11]	8.71E-04 [4]	0.0075	0.00022	0.0023
Benzo(a)anthracene	0.401	1.25E-06	1	8.71E+05 [8]	--	3.00E-02 [9]	1.43E-02 [11]	2.19E-02 [4]	0.0075	0.00022	0.0023
Benzo(b)fluoranthene	0.274	1.20E-06	1	6.31E+05 [8]	--	7.00E-02 [9]	1.72E-02 [11]	1.58E-02 [4]	0.0075	0.00022	0.0023
Benzo(k)fluoranthene	0.218	5.74E-07	1	1.00E+06 [8]	--	8.00E-02 [9]	1.32E-02 [11]	2.51E-02 [4]	0.0075	0.00022	0.0023
Benzo(g,h,i)perylene	0.213	2.18E-07	1	3.16E+06 [8]	--	5.00E-02 [10]	6.78E-03 [11]	7.94E-02 [4]	0.0075	0.00022	0.0023
Benzo(a)pyrene	0.395	9.60E-07	1	1.10E+06 [8]	--	7.00E-02 [9]	1.25E-02 [11]	2.75E-02 [4]	0.0075	0.00022	0.0023
Chrysene	0.377	1.47E-06	1	3.09E+05 [8]	--	4.00E-02 [9]	2.60E-02 [11]	7.76E-03 [4]	0.0075	0.00022	0.0023
Fluoranthene	0.329	3.77E-06	1	1.66E+05 [8]	--	5.00E-02 [10]	3.72E-02 [11]	4.17E-03 [4]	0.0075	0.00022	0.0023
Fluorene	0.203	1.66E-05	1	1.51E+04 [8]	--	5.00E-02 [10]	1.49E-01 [11]	3.80E-04 [4]	0.0075	0.00022	0.0023
Indeno(1,2,3-cd)pyrene	0.208	8.28E-08	1	1.00E+07 [8]	--	8.00E-02 [9]	3.48E-03 [11]	2.51E-01 [4]	0.0075	0.00022	0.0023
Phenanthrene	0.446	1.74E-05	1	3.72E+04 [8]	--	5.00E-02 [10]	8.84E-02 [11]	9.33E-04 [4]	0.0075	0.00022	0.0023
Pyrene	0.623	7.72E-06	1	1.51E+05 [8]	--	5.00E-02 [10]	3.93E-02 [11]	3.80E-03 [4]	0.0075	0.00022	0.0023
Barium	83	2.63E-02	0.07	-	3.16E+02	1.00E-02 [5]	1.50E-01 [9]	9.43E-03 [12]	0.0075	0.00022	0.0023
Cadmium	1.17	5.86E-05	0.01	-	2.00E+03	9.60E-01 [9]	3.64E-01 [9]	7.54E-03 [12]	0.0075	0.00022	0.0023
Chromium	13	1.72E-05	0.005	-	7.54E+04	1.00E-02 [9]	7.50E-03 [9]	3.45E-01 [12]	0.0075	0.00022	0.0023
Lead	138	3.47E-04	0.15	-	3.98E+04	3.00E-02 [9]	4.50E-02 [9]	1.88E-02 [12]	0.0075	0.00022	0.0023
Mercury	0.18	2.27E-06	0.07	-	7.94E+03	4.00E-02 [6,9]	3.75E-02 [6,9]	3.26E-01 [12]	0.0075	0.00022	0.0023
Selenium	0.92	2.31E-05	0.44	-	3.98E+03	1.00E-02 [5]	1.60E-02 [9]	1.43E-01 [12]	0.0075	0.00022	0.0023

mg = milligrams.
kg = kilograms.
L = liters.
dy = days.
DW = dry weight.
WW = wet (fresh) weight.

1. Assumed values for organics; see associated table for metal references.
2. U.S. EPA (1999a) Partition Coefficients for Metals in Surface Water, Soil, and Waste (draft). June 22.
3. Calculated as 0.5 kg/kgBW-dy x 0.015 kg body weight (for worms); 0.0145 kg/kgBW-dy x 0.015 kg (for soil); 0.151 L/kgBW-dy x 0.015 kg (for surface water).
4. For organic constituents, log BA_{mammal} = -7.6 + log K_{ow}. (U.S.EPA 1999).
3. Calculated as 0.5 kg/kgBW-dy x 0.015 kg body weight (for worms); 0.0145 kg/kgBW-dy x 0.015 kg (for soil); 0.151 L/kgBW-dy x 0.015 kg (for surface water).
5. Reportedly does not bioaccumulate; lowest value of assessed metals applied [U.S. EPA (2005b) http://www.epa.gov/region5/superfund/ecology/html/toxprofiles.htm].
6. Value for mercuric chloride applied.
7. U.S. EPA (2004a). Water9 Version 2.0.0 Database.
8. TPHCWG (1998). Composition of Petroleum Mixtures. May.
9. U.S. EPA (1999). Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities. EPA 530-D-99-001A, August.
10. No value available; midpoint of available values for PAHs applied.
11. Calculated from the following regression equation: log BCF = 1.588 - 0.578 x Log K_{ow} per U.S. EPA (1999).
12. For metals, BA_{mammal} values were back-calculated from BCF values presented in U.S. EPA (1999), Table D-3 for short-tailed shrew, using a soil ingestion rate of 0.0145 kg/kg-dy and a body weight of 0.015 kg.